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6. AUTHOR(S)

George C. Tillery
Steven M. Buc

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)

System Planning Corporation
1500 Wilson Blvd
Arlington, Virginia 22209

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ANTI-HELICOPTER MINE SYSTEM STUDIES AND ANALYSES

SEPTEMBER 1989

Sponsored by
U.S. Army Belvoir Research, Development
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For
Dr. Divykant L. Patel, STRBE-NM
and
Mr. Thomas F. Hafer, DARPA

By

George C. Tillery
Steven M. Buc

System Planning Corporation
1500 Wilson Blvd
Arlington, Virginia   22209

Summary

This document is submitted as an annual project status report in accordance with CDRL A003 and serves as a partial deliverable in response to contract Tasks 2 and 5 of Section C.2 of the contract statement of work.

This document is a compilation of three studies and analyses pertaining to the Anti-Helicopter Mine system:

1) "Concept For The Employment Of The Anti-Helicopter Mine (AHM)"

2) "Operational and Organizational Plan For The Anti-Helicopter Mine (AHM)"

3) "Modeling And Analysis For The Anti-Helicopter Mine"

CONCEPT FOR THE EMPLOYMENT OF THE ANTI-HELICOPTER MINE (AHM)
(08/01/89)

1.   PURPOSE. To propose an operational concept for the Anti-Helicopter Mine (AHM), including characteristics and rationale.

2.   ASSUMPTIONS.

    a.   Soviet and U.S. Army doctrine and tactics will evolve but will not change substantially prior to AHM fielding.

    b.   The Forward Area Air Defense System (FAADS) will be fielded.

3.   THREAT TO BE COUNTERED.

    a.   Soviet/Warsaw Pact helicopter forces now pose a significant threat to the Army's ability to execute AirLand Battle doctrine. Over the past decade Soviet/Warsaw Pact helicopter forces have grown ten fold in sheer numbers. Not only have they grown in quantity but their quality has also been greatly improved. These forces threaten the integrity of friendly combat forces, the ability to sustain those forces and the ability to synchronize their application in a coherent manner.

    b.   The threat to be countered is Soviet attack helicopter regiments, currently equipped with 40 HIND and 20 HIP helicopters, and air assault brigades and battalions, supported by transport helicopter regiments equipped with 56 cargo and troop helicopters, normally 32 HIP and either 24 HOOK or HALO helicopters. Attack helicopters are armed with a variety of armaments. Of primary concern are anti-armor systems, such as the AT-6 SPIRAL with a range of 5 km and a penetration of 600 mm to 700 mm of RHA, automatic cannon and high explosive rockets.

    c.   Soviet doctrine envisions the employment of armed helicopter and air assault units in a variety of roles. Armed helicopter units will be employed as highly mobile anti-armor platforms. Armed helicopter and air assault units will be employed in combination, or independently, to disrupt friendly forces command and control, to destroy logistic sites and other high value targets and to seize key terrain behind the "friendly" forward line of own troops (FLOT) for short periods of time.

    d.   These helicopter units will normally be located within 100 km forward of the FLOT. This is predicated on the anticipated combat radius of current and future Soviet helicopters and Soviet air assault doctrine which indicates that pick-up zones (PZs) for air assault forces will be located approximately 20 km from the FLOT. Soviet/Warsaw helicopter forces will rarely, if ever, be employed at depths greater than 150 km to the rear of the FLOT.

    e.   Soviet/Warsaw Pact helicopter forces can normally be expected to operate in flights of from two (2) to four (4) aircraft. Anti-armor missions will, usually, be conducted by armed helicopter formations of squadron size, while air assault missions may be conducted by transport helicopter formations of from squadron to regimental size. Prior to commencing engagement, these formations will be flying at altitudes of approximately 50 m above the ground at speeds of between 200 km/hr and 300 km/hr.

4.   OPERATIONAL CONCEPT.

   a.   Operational Characteristics.

      (1)   Means of Delivery. The AHM can be emplaced by MLRS rockets and the Army Tactical Missile System (Army TACMS), and may be delivered by Air Force aircraft, helicopter and ground vehicle mounted VOLCANO or by hand emplacement.

      (2)   Lethality.

         (a)   The AHM will be able to engage helicopters at altitudes of from 5 m to at least 150 m above the ground. The ability to engage targets up to an altitude of 300 m above the ground is desired.

         (b)   The AHM will be able to engage and destroy both hovering helicopters and helicopters moving a speeds up to 350 km/hr.

         (c)   The AHM warhead will have at least a .5 single shot probability of kill against current and future Soviet/Warsaw Pact helicopters at an altitude of 100 m, with a .75 single shot probability of kill desired. The single shot probability of kill of individual mines is not necessarily the primary criteria by which the AHM's lethality should be evaluated. The primary target for AHM is not individual helicopters, but, rather, helicopter forces. Soviet doctrinal norms indicate that an AHM minefield should be able to destroy greater than 60% of the helicopters available to a Soviet helicopter unit. This rate of attrition, assuming an 80% operational ready rate for those units, results in only 30% of a unit remaining to accomplish its assigned mission after encountering an AHM minefield.

      (3)   Target Acquisition.

         (a)   The AHM's primary sensor will have hemispherical coverage. It will acquire targets through a full 360 degrees of azimuth and 0 to 90 degrees of elevation.

         (b)   The AHM's primary sensor will be a passive system. This will reduce the possibility of an AHM minefield's early detection and, consequently, will reduce the chance of enemy helicopters effectively employing countermeasures or avoiding the minefield. Submunition sensors, if such are employed, may be either active or passive. The AHM will also be able to differentiate between enemy and friendly helicopters with a 99% or greater confidence.

      (4)   System Operation.

         (a)   A certain number of AHMs, perhaps an MLRS rocket pod or an Army TACMS load, will constitute a basic minefield. AHMs will be capable of communicating with each other. All the AHMs in a basic minefield will be netted and will operate in concert. Larger AHM minefields will be created by netting two or more basic minefields together. It is envisioned that, in the mines that constitute a basic minefield, there may be one controller mine that will orchestrate the activities of the remaining mines. The controller "mine" may in fact be an inert, or dummy mine, lacking a target attack capability.

         (b)   An AHM minefield will have the capability to recognize enemy helicopter formations and to delay engagement until the maximum effect can be achieved against a particular formation. If an AHM minefield encounters an unfamiliar enemy

2

helicopter formation, it will commence engagement when the first helicopter enters the engagement zone of the first AHM in its flight path.

(c)   Mines within the AHM minefield will be capable of staggered engagement, to reduce the number of multiple engagements of a single target.

b.   System Constraints.

(1)   Design.

(a)   The AHM will be a member of the Army's family of Wide Area Mines (WAM) and will share common components to the maximum extent possible.

(b)   AHM delivery systems will be designed so that there will be a greater than .8 probability that a given mine will be operational after emplacement in the designated target area.   There will be a greater than .99 probability that an AHM minefield will have an operational controller, if such a mechanism is employed.   This may require more than one "mine" in each basic minefield has the ability to control that minefield.

(c)   AHMs will be electronically programmable.   AHMs in both MLRS rockets and Army TACMS will be electronically programmable through an interface cable, or device performing a similar function, which connects the AHM carrying munition to the MLRS vehicle electronics.

(d)   The AHM will have an operational life of no less than 96 hours (the nominal temporal extent of the corps area of operations) with a programmable self-destruct/disarm capability.   An operational life of 15 days is desired.   The shelf life of the AHM should be at least 10 years, with a 99% success rate, with 20 years desired.

(e)   AHM will have a built-in explosive ordnance disposal capability.

(2)   Operational Environmental.

(a)   The AHM will be capable of operating year round in hot, basic and cold climatic zones per AR 70-38, day or night, in all types of weather (in which helicopters are capable of flying) without significant degradation.

(b)   The AHM will be capable of operation with minimal degradation on terrain with slopes of up to 30 degrees.

(c)   The basic AHM minefield will have the capability to protect itself from dismounted personnel.   Execution of this capability must not result in mine self-destruction.   (This may mean that a certain number of "dumb" mines are included with the AHMs in a basic AHM minefield.)

(d)   AHM will be capable of engaging targets through a variety of possible countermeasures, to include flares and other signature duplication devices, chaff and jamming, without significant degradation.

(3)   NBC Survivability.   AHM is mission essential.   AHM will be nuclear and chemical hardened.

(4) **Logistics**.

    (a) The AHM will be a "wooden round".

    (b) AHM will have a go/no-go test for the operator.

(5) **Transportability**. MLRS rockets and Army TACMS loaded with AHMs will meet the same transportability criteria as other MLRS rocket and Army TACMS munitions. Hand emplaced AHM and AHM munitions fired from VOLCANO will meet WAM transportability criteria.

(6) **MANPRINT**.

    (a) **Manpower/Force Structure**. This concept will not generate new manpower requirements nor will it impact force structure.

    (b) **Personnel Assessment**. This concept will not generate new Military Occupational Specialties (MOS) nor changes in the MOS structure.

    (c) **Training**.

        (1) This concept will not create new doctrine. AHM employment will be consistent with AirLand Battle and AirLand Battle-Future doctrine and will be included in otherwise existing doctrinal publications.

        (2) This concept will require additional training for commanders and staffs, but will require only minimal, if any, additional training for maintenance personnel and operators. This concept will lead to the publication of new training documents. Maintenance instructions will be included in otherwise existing maintenance publications.

        (3) A training device will be required to provide AHM specific technical and tactical training for operators. This device must be compatible with other systems used for force on force training, such as MILES.

        (4) AHM will be included in the software package for training simulators.

    (d) **Human Factors Engineering**. AHM will incorporate appropriate human factors engineering.

    (e) **System Safety**. AHM will meet all applicable safety standards.

    (f) **Health Hazard Assessment**. AHM will meet all applicable health hazard requirements.

(7) **Communications**.

    (a) AHM will be compatible with appropriate target acquisition, digital message, maneuver and air defense command and control and tactical and technical fire control systems -- the Army Tactical Command and Control System (ATCCS). AHM will be in the Advanced Field Artillery Tactical Data System (AFATDS) and Forward

Area Air Defense Command, Control, Communications and Intelligence System (FAADS C^{3}I) software.

(b)   A two way communications capability is desired, through which the AHM minefield can provide a status report and intelligence.

(c)   While capable of autonomous operation, the AHM will also have the capability to be remotely activated/deactivated and will be compatible with the Countermobility Remote Control System (CIRCE).

(8)   <u>Standardization and Interoperability</u>. The AHM will meet all standardization and interoperability requirements.   Currently, none have been defined.

c.   <u>Organizational Plan</u>.   AHM is simply a munition.   Its allocation will based on availability and the commander's battlefield requirements expressed in a Controlled Supply Rate (CSR).   AHM's fielding will not require the creation of new units, nor will its fielding affect existent units.

d.   <u>Operational Employment</u>.

(1)   <u>Methodology</u>.   Because of the the rapid tempo and fluid nature of the AirLand Battle, and because of the requirement to employ limited resources against a numerically superior enemy, the Army has developed a proactive employment methodology.   The AHM will be employed using the "decide/detect/deliver" methodology. Given the corps commander's concept of operations and his intent, a <u>decision</u> must be made regarding where, when, how (delivery means -- MLRS rocket, Army TACMS, VOLCANO, etc), and how many AHMs will be employed.   A decision must also be made selecting and allocating target acquisition systems, if required, and defining command relationships.   Once the specified target is <u>detected</u>, or at a designated time or event, the AHM munition is <u>delivered</u>, that is, emplaced.

(2)   <u>Responsibility</u>.

(a)   While not delivered by air defense systems, per se, AHM is an air defense system, in so much as it performs an air defense function, just as a tank or an attack helicopter is a fire support system when employed to deliver indirect fires. Doctrinally, the employment of indirect fires provided by tanks or helicopters should be planned and coordinated by the appropriate fire support coordinator.   It follows, then, that the corps air defense coordinator or, if the AHM is allocated by corps to a subordinate division, the division air defense coordinator will be responsible for planning and coordinating AHM employment.

(b)   The concept for where, when and how AHM minefields will be employed, regardless of how they are emplaced, will be developed by the corps air defense coordinator, in coordination with the corps operations officer, the corps engineer, the corps fire support coordinator and the corps air operations staff to best implement the corps commander's concept and intent.   If AHM fires are allocated to a subordinate division, essentially the same process occurs within its staff.

(3)   <u>Control</u>.

(a)   AHM must, at a minimum, be addressed in those portions of the Operations Order, or Plan, dealing with Air Defense, Fire Support and Engineer Support.

AHM minefield locations will be included in the Mines, Obstacles and Fortifications Annex. Additionally, AHM minefield locations should be included in the Air Defense and the Airspace Management Annexes.

(b)   An AHM minefield will either be command controlled or operate autonomously. If it is programmed to be command controlled and loses its communications link, an AHM minefield will default to autonomous operation. The AHM's programmable disarm, or self-destruct, will be set in concert with the corps or division commander's concept and intent, when the AHM munition is prepared for delivery. Even if all communication is lost with the minefield, the commander can be reasonably assured that at a specified time the AHM minefield will be deactivated.

(c)   An AHM minefield will probably report to, and be controlled by, the air defense unit responsible for countering the helicopter threat in that portion of the battlefield in which the AHM minefield is emplaced. It may report to, or be controlled by, a maneuver unit, probably army aviation, if that maneuver unit is expected to interact with the minefield. An AHM minefield will not normally report to, or be controlled by, its delivery unit. An AHM minefield will not normally report to, or be controlled by, a corps or division headquarters. This method of control would be too cumbersome for either AirLand Battle or AirLand Battle-Future doctrine.

(4)   Employment.

(a)   The AHM may be employed in two ways. If there is a high degree of certainty in the Intelligence Preparation of the Battlefield (IPB), the corps or division commander may decide to emplace AHM minefields prior to the commencement of the operation, freeing his delivery systems during the battle for other missions. If he is not confident of the IPB (the situation may be highly fluid or vague) the commander may opt to emplace AHM minefields when a specified helicopter threat is detected, or when time or other events indicate such a threat is about to be employed. In this case, one or more sensor systems may be allocated to monitor a Named Area of Interest (NAI). Once a given event occurs in that NAI, the requisite number of AHMs are emplaced in the appropriate Target Area of Interest (TAI). It must be remembered that while AHM control and planning is centralized, because of the rapid tempo of the AirLand Battle, execution must be decentralized. Consequently, designated sensor systems must be linked directly to the units which will emplace the AHM minefield(s). The unit commander is given employment parameters and is expected to employ the AHM when those parameters are met without requesting permission from corps or division. He will, of course, inform corps or division, at the first opportunity, that the AHM minefield has been emplaced.

(b)   Part of the IPB process is to determine the size of the helicopter threat, how that threat is likely to be employed, what air avenues of approach into the corps area of operations the threat will be most apt to take and the probable location of the forward airfields, PZs and landing zones (LZs) the threat is likely to use. AHM TAIs will include appropriate locations along potential air avenues of approach and potential forward airfields, PZs and LZs. AHM minefields will be tailored to terrain and to the size of the targeted helicopter force.

(c)   On the occurrence of a specified event, or time, probably a defined enemy activity in an NAI, delivery systems are placed in the proper state of readiness, and mines are prepared. On the occurrence of another specified event, or time, the AHMs are delivered to the designated target area.

6

(d)   Once deployed on the ground, each basic AHM minefield will establish its internal communications net. If more than one basic minefield is included in the tailored minefield, those basic minefields will also net. Netting between basic minefields may simply occur between the controller mines in each basic field. One of the controller mines would be designated the controlling mine for the tailored minefield. The minefield may then report to its controlling unit.

(e)   When a target is detected the AHM tailored minefield will compare that target against specified formations, or numbers of aircraft. Engagement may commence when the first helicopter enters the first mine's engagement zone, or engagement may be delayed until an optimum number of aircraft have entered the minefield. Engagement will then be initiated simultaneously by some portion of the mines in the field. The remaining mines will be in a delayed engagement mode to reduce the occurrence of multiple engagements which would increase the chance of following helicopters being able to negotiate the minefield safely.

(f)   While the AHM minefield may be centrally controlled by one controller mine, helicopter tracking and engagement are decentralized. Each individual mine tracks and engages the nearest helicopter within its sensor footprint. If target data is passed to controller mine(s), and the command to begin engagement is, in turn, passed from the minefield controller mine to all other mines in the minefield, there is no need for all AHMs in a minefield to communicate with all other AHMs in that minefield.

(5)   Role.

(a)   AHM will be employed in close, deep and rear operations both within the FAADS umbrella and outside the FAADS umbrella to degrade the effectiveness of enemy helicopter forces before they engage friendly forces.

(b)   Close/Rear Operations.

(1)   A helicopter threat is difficult to counter. By flying below radar line-of-sight (LOS) and by employing pop-up engagement techniques, helicopters can, to a large extent, render LOS air defense systems ineffective. It was for this reason that the Non-Line-of-Sight system (NLOS) was developed. NLOS will complement the LOS-Forward component of FAADS, providing combined arms team with an effective means to deal with the helicopter threat. AHM, either MLRS, hand or VOLCANO emplaced, will both supplement and complement NLOS in this role.

(2)   The cost of NLOS, if not operational necessity, will preclude it from being everywhere it is needed on the battlefield. It will primarily be deployed in the division forward area -- the brigade area of operations, along with the LOS-Forward system. This leaves the division and corps rear areas comparatively unprotected. AHM minefields will supplement NLOS by providing an anti-helicopter capability in those areas within the FAADS umbrella without NLOS coverage and in those areas outside the FAADS umbrella in the corps rear area. By providing a significantly cheaper, if less capable, substitute for NLOS, AHM will enable the maneuver commander to conserve his NLOS systems, massing their fires where they can be employed to the greatest effect.

(3)   AHM minefields will also complement NLOS. AHM minefields within the FAADS umbrella will not only kill enemy helicopters, but will also drive them into the engagement envelope of LOS-Forward and provide target detection for NLOS fires.

7

(c)   Deep Operations.

(1)   There is a need to deny Soviet/Warsaw Pact helicopter units freedom of maneuver in that part of the corps area of operations beyond the FAADS umbrella forward of the FLOT. While NLOS provides FAADS an effective anti-helicopter capability, no such capability exists beyond the FAADS umbrella.

(2)   Even if enemy helicopter forces, operating beyond the FAADS umbrella, fly within the envelope of air defense radars, high and medium air defense systems (HIMAD), while capable of engaging helicopters, will not normally do so. While HIMAD systems have the ability to engage helicopter targets beyond the FLOT, they have, at least in the initial stages of a conflict, higher priority targets to engage such as high performance aircraft and tactical missiles. There is also the problem of target acquisition and engagement. Because it is standard operating procedure for Soviet/Warsaw Pact helicopter forces to move along covered and concealed air avenues of approach, flying at low altitudes, it will be difficult for air defense radars to acquire them before they engage friendly forces. Even if these helicopter forces are detected, and HIMAD fire units are available, the engagement windows could prove too fleeting for successful engagement.

(3)   Although rocket and missile artillery has the range to attack enemy helicopter forces beyond the FAADS umbrella, it does not pose a major threat to those forces. Unless helicopters are attacked while either hovering or on the ground, conventional artillery fires will probably not have a significant impact on them because of their inherent mobility and agility.

(4)   As with artillery, Army Aviation and Air Force assets do not pose a major threat to enemy helicopter forces. There are two main reasons for this. First, at least in the initial stages of a conflict, the majority of Air Force assets, like HIMAD systems, will be involved in the counterair battle. Secondly, neither Air Force assets nor Army Aviation can be expected to successfully conduct cross-FLOT operations against a coherent, modern air defense without a significant Suppression of Enemy Air Defense (SEAD) effort. The SEAD effort will be difficult to implement, particularly in the initial stages of a conflict, because of other demands on corps fire support assets.   Fire support is crucial to the successful conduct of SEAD in the corps area of operations.

(5)   AHM minefields, delivered primarily by MLRS rockets and Army TACMS and possibly by aircraft, will address this need. They could, if skillfully employed, either render enemy helicopter forces combat ineffective through the destruction of large numbers of helicopters or drive them into the HIMAD engagement envelope. Even if no HIMAD unit can engage those helicopter forces, their early detection will better enable the corps commander to prepare to defend against them and will provide him a clearer picture of the enemy commander's overall intent.

e.   Doctrinal Considerations Affecting the Development of This Concept.

(1)   Soviet Doctrine. Soviet doctrine emphasizes cover, concealment and deception. Even if the Soviets realized that the AHM was being employed, and knew its vertical and slant ranges, it is doubtful that they would alter their helicopter employment doctrine. By flying their helicopters at a higher altitude they would increase their susceptibility to detection, and, consequently, to attack. Detection of these helicopter forces, even if they were not attacked, would provide friendly forces valuable tactical intelligence on the Soviet commander's concept and intent. AHM will not be everywhere on the battlefield. A less than certain chance of helicopter forces encountering an AHM

8

minefield, coupled to a doctrinal requirement to achieve surprise, will predispose Soviet/Warsaw Pact commanders to adhere to established doctrine.

(2) Air Defense Doctrine. The AHM will not be employed in isolation. AHM must be employed in accordance with U. S. Army air defense doctrine and in concert with other air defense systems. The combination of other air defense systems and air defense doctrine dictates both the role in which the AHM will be employed and and the capabilities it will require. A key tenet of evolving Army air defense doctrine, that impacts on this operational concept, is the mandate to deny the enemy freedom of maneuver in the air space over his rear area of operations.

(3) Family of Wide Area Mines (WAM) Concept.

(a) "Dumb" mines are high leverage systems only when employed with other means of target attack, either observed indirect or direct fires. They are not expected so much to kill enemy systems as to impede their freedom of maneuver. When not "overwatched" by fires, minefields will only impede an enemy with an effective countermine capability, such as the Soviets possess, for a short period of time and will probably not damage or destroy enemy vehicles in any significant quantity. Additionally, the requirement to reposition forces to provide "overwatching fires" inhibits the maneuver commander's flexibility.

(b) Smart mines, such as WAM, are, on the other hand, stand-alone high leverage systems. Stand-alone lethality is WAM's most important attribute. WAM should be able to both delay enemy forces and/or significantly degrade their ability to fight, through destruction of enemy systems, without "overwatching fires". Because it does not require "overwatching fires", WAM conserves forces, freeing them for employment elsewhere, greatly increasing the maneuver commander's flexibility.

(4) AirLand Battle and AirLand Battle-Future Doctrine.

(a) The four tenets of AirLand Battle doctrine- initiative, agility, depth and synchronization, indicate that a primary means for AHM delivery will be MLRS rockets and Army TACMS. To conform to the tenets of AirLand Battle, given its rapid tempo and chaotic nature, requires a reliable means to rapidly emplace AHM at depth. Aircraft are not a reliable means of delivery for the AHM because they: lack survivability in a high mid-intensity to high intensity conflict, where the helicopter threat is the greatest; are weather dependent; and, in the case of fixed wing aircraft which are Air Force assets, may not be immediately responsive to the needs of the maneuver commander. Other means of delivery lack either range or speed of emplacement, or both.

(b) Other means of AHM delivery are, however, desirable. They provide the commander a certain degree of flexibility. He will not have to commit his MLRS assets to every AHM mission and, thereby, forgo the benefit of having those MLRS systems deliver other high leverage munitions. In cross FLOT operations conducted by Army aviation units, VOLCANO equipped helicopters or Air Force aircraft could be employed to secure the flanks and rear of those units from attack by enemy helicopter forces with AHM minefields. Behind the FLOT, VOLCANO equipped helicopters or ground vehicles might dispense AHMs to block an ingressing or projected enemy air assault or attack helicopter force. Hand emplacement may be necessary in the event that the other means of emplacement are unavailable. Hand emplacement would also provide a high degree of assurance, that an AHM minefield was properly emplaced with respect to such considerations as mine LOS.

9

(c)   AirLand Battle-Future doctrine adds a fifth tenet to the four found in AirLand Battle doctrine, endurance.   Endurance is the ability of a force to sustain high levels of combat potential relative to its opponent over the duration of an operational campaign.   AHM can provide additional operational depth to this tenet by freeing other air defense assets for use elsewhere.

(5).   _Mine Employment and Fire Support Doctrine_.   Mine employment and fire support doctrines dictate that the corps will be the echelon of command that controls AHM employment.

(a)   _Mine Employment Doctrine_.   Under current mine employment doctrine the corps commander would be the approval authority for the employment of AHM in the corps area of operations, regardless of the means of delivery.   The corps commander may, however, delegate that authority to individual division commanders.   This would be a particularly appropriate action in the case of hand emplaced AHM minefields.

(b)   ·_Fire Support Doctrine_.   Even if mine employment doctrine allowed the division commander to employ AHM without prior approval from the corps commander, the majority of AHM delivery systems will still be controlled by the corps commander.   Corps allocates Air Force sorties to subordinate divisions.   Army TACMS is a corps weapon system, although its employment may be circumscribed by higher echelon commanders.   Army TACMS will not normally be allocated to divisions, although Army TACMS fires, delivered by corps artillery MLRS battalions, may be provided to divisions. Additionally, the bulk of corps MLRS assets are located in corps artillery MLRS battalions. While these battalions' fires may be allocated to a particular division, the battalions themselves may remain under corps control.   Finally, the corps is the focal point for the Army's deep target acquisition systems.   All this does not mean, however, that AHM fires may not be allocated by the corps commander to subordinate units.

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OPERATIONAL & ORGANIZATIONAL PLAN FOR THE ANTI-HELICOPTER MINE (AHM)
(08/01/89)

1. TITLE.

    a. Descriptive Program Title.   The Anti-Helicopter Mine (AHM).

    b. CARDS Reference Number: TBA.

2. NEED.

    a. There is a need for an Anti-Helicopter Mine (AHM), emplaced by MLRS rockets and the Army Tactical Missile System (Army TACMS), by Air Force aircraft, helicopter and ground vehicle mounted VOLCANO and by hand emplacement, to degrade the effectiveness of enemy helicopter forces before they engage friendly forces in close, deep and rear operations.   This mine will be a member of the Army Family of Wide Area Mines (WAM).

    b. Soviet/Warsaw Pact helicopter forces now pose a significant threat to the Army's ability to execute AirLand Battle doctrine.   Over the past decade Soviet/Warsaw Pact helicopter forces have grown ten fold in sheer numbers.   Not only have they grown in quantity but their quality has also been greatly improved.   These forces threaten the integrity of friendly combat forces, the ability to sustain those forces and the ability to synchronize their application in a coherent manner.   This need is identified in the Air Defense Mission Area Analysis.

3. THREAT.

    a. Threat to Be Countered.

        (1)   The threat to be countered is Soviet attack helicopter regiments, currently equipped with 40 HIND and 20 HIP helicopters, and air assault brigades and battalions, supported by transport helicopter regiments equipped with ·56 cargo and troop helicopters, normally 32 HIP and either 24 HOOK or HALO helicopters.   Attack helicopters are armed with a variety of armaments.   Of primary concern are anti-armor systems, such as the AT-6 SPIRAL with a range of 5 km and a penetration of 600 mm to 700 mm of RHA, automatic cannon and high explosive rockets.

        (2)   Soviet doctrine envisions the employment of armed helicopter and air assault units in a variety of roles.   Armed helicopter units will be employed as highly mobile anti-armor platforms.   Armed helicopter and air assault units will be employed in combination, or independently, to disrupt friendly forces command and control, to destroy logistic sites and other high value targets and to seize key terrain behind the forward line of own troops (FLOT) for short periods of time.

        (3)   These   helicopter units will normally be located within 100 km forward of the FLOT.   This is predicated on the anticipated combat radius of current and future Soviet helicopters and Soviet air assault doctrine which indicates that pick-up zones (PZs) for air assault forces will be located approximately 20 km from the FLOT.   Soviet/Warsaw helicopter forces will rarely, if ever, be employed at depths greater than 150 km to the rear of the FLOT.

(4)   Soviet/Warsaw Pact helicopter forces can normally be expected to operate in flights of from two (2) to four (4) aircraft. Anti-armor missions will, usually, be conducted by armed helicopter formations of squadron size, while air assault missions may be conducted by transport helicopter formations of from squadron to regimental size. Prior to commencing engagement, these formations will be flying at an altitude of approximately 50 m above the ground at speeds of between 200 km/hr and 300 km/hr.

b. **System Vulnerability**.

(1)   Because of the lethality of their munitions, AHM delivery vehicles will be subject to attack by the full spectrum of enemy capabilities. While ground forces with direct fire weapons cannot be ignored, the primary threat to an AHM delivery vehicle will come from indirect fire systems, including artillery and frontal aviation, from air defense systems and from radio-electronic combat. Random point minefields, emplaced by both enemy and friendly forces, will also be a threat to the AHM delivery vehicle. The Army TACMS will be subject to attack by enemy anti-tactical ballistic missile systems (ATMs).

(2)   The AHM, itself, will be subject to the full spectrum of enemy countermine systems, possibly including directed energy. Additionally, the AHM could be subjected to small arms and artillery fire, while sensors may be subject to helicopter signature duplication devices, to chaff and to jamming.

c. **References**.   .

(1)   DARPA AHM - Mid Term Review.

(2)   Romasevich, V.F. and G.A. Samoylov. **Practical Helicopter Operations**. Moscow: USSR Ministry of Defense, 1980.

(3)   U.S. Army Field Manual 100-2-1, The Soviet Army: Operations and Tactics, July 1984.

(4)   U.S. Army Field Manual 100-2-2, The Soviet Army: Specialized Warfare and Rear Area Support, July 1984.

(5)   U. S. Army Field Manual 100-2-3, The Soviet Army: Troops, Organization and Equipment, July 1984.

(6)   Soviet Army Studies Office, U.S. Army Combined Arms Center, Special Study: The Soviet Conduct of War, February 1988.

4. OPERATIONAL CHARACTERISTICS.

a. **Means of Delivery**. The AHM can be emplaced by MLRS rockets and the Army TACMS, by Air Force aircraft, helicopter and ground vehicle mounted VOLCANO and by hand emplacement.

b. **Lethality**.

(1)   The AHM will be able to successfully engage helicopters at a height of from 5 m to at least 150 m above the ground. The ability to engage targets up to a height of 300 m above the ground is desired.

2

(2) The AHM will be able to successfully engage both hovering helicopters and helicopters moving a speeds up to 350 km/hr.

(3) The AHM will be able to successfully engage a helicopter conducting evasive maneuvers at from -.5 g to 3 g in the vertical plane and 3 g in the horizontal plane.

(4) The AHM warhead will have at least a .5 single shot probability of kill against current and future Soviet/Warsaw Pact helicopters at a height of 100 m above the ground, with a .75 probability of single shot kill desired.

c. Target Acquisition.

(1) The AHM's primary sensor will have hemispherical coverage. It will acquire targets through a full 360 degrees of azimuth and 0 to 90 degrees of eleva

(2) The AHM's primary sensor will be a passive system. Submunition sensors, if such are employed, may be either active or passive.

(3) The AHM will differentiate between enemy and friendly helicopters with a 99% or greater confidence highly desired.

d. System Operation.

(1) A certain number of AHMs, perhaps an MLRS rocket pod or an Army TACMS load, will constitute a basic minefield. AHMs will be capable of communicating with each other. All the AHMs in a basic minefield will be netted and will operate in concert. Larger AHM minefields will be created by netting two or more basic minefields together. In the mines that constitute a basic minefield, there may be one controller mine that will orchestrate the activities of the remaining mines. The controller "mine" may in fact be an inert, or dummy mine, lacking a target attack capability.

(2) An AHM minefield will have the capability to recognize enemy helicopter formations and to delay engagement until the maximum effect can be achieved against a particular formation. If an AHM minefield encounters an unfamiliar helicopter formation it will commence engagement when the first helicopter in that formation enters the engagement zone of the first AHM in its flight path.

(3) Mines within the AHM minefield will be capable of staggered engagement.

(4) While capable of autonomous operation, the AHM will also have the capability to be remotely activated/deactivated and will be compatible with the Countermobility Remote Control System (CIRCE).

5. OPERATIONAL PLAN.

a. Methodology. Because of the the rapid tempo and fluid nature of the AirLand Battle, and because of the requirement to employ limited resources against a numerically superior enemy, the Army has had to develop a proactive employment methodology. The AHM will be employed using the "decide/detect/deliver" methodology. Given the corps commander's concept of operations and his intent, a decision will be made, even for contingency missions, regarding where, when, how (delivery means -- MLRS rocket, Army TACMS, VOLCANO, etc), and how many AHMs

will be employed. A decision must also be made selecting and allocating target acquisition systems, if required, and defining command relationships. Once the specified target is detected, or at a designated time or event, the AHM munition is delivered, that is, emplaced.

b. Responsibility.

The concept for where, when and how AHM minefields will be employed, regardless of how they are emplaced, will be developed by the corps air defense coordinator, in concert with the corps operations officer, the corps engineer, the corps fire support planner and the corps air operations staff to best implement the corps commander's concept and intent. If AHM fires are allocated to a subordinate division, essentially the same process occurs within its staff.

c. Control.

(1)   AHM must, at a minimum, be addressed in those portions of the Operations Order, or Plan, dealing with Air Defense, Fire Support and Engineer Support. AHM minefield locations will be included in the Mines, Obstacles and Fortifications Annex. Additionally, AHM minefield locations should be included in the Air Defense and the Airspace Management Annexes.

(2)   An AHM minefield will either be command controlled or operate autonomously. If it is programmed to be command controlled and loses its communications link, an AHM minefield will default to autonomous operation. When the AHM munition is prepared for delivery, the AHM's programmable disarm, or self-destruct, will be set to deactivate or to destroy the AHM at a time dictated by the corps or division commander's concept and intent.

(3)   An AHM minefield will probably report to, and be controlled by, the air defense unit responsible for countering the helicopter threat in that portion of the battlefield in which the AHM minefield is emplaced. It may report to, or be controlled by, a maneuver unit, probably army aviation, if that maneuver unit is expected to interact with the minefield. An AHM minefield will not normally report to, or be controlled by, its delivery unit. An AHM minefield will not normally report to, or be controlled by, a corps or division headquarters.

d. Employment.

(1)   The AHM may be employed in one of two ways. If there is a high degree of certainty in the Intelligence Preparation of the Battlefield (IPB), the corps or division commander may decide to emplace AHM minefields prior to the commencement of the operation, freeing his delivery systems during the battle for other missions. If he is not confident of the IPB (the situation may be highly fluid or vague) the commander may opt to emplace AHM minefields when a specified helicopter threat is detected, or when time or other events indicate such a threat is about to be employed. In this case, one or more sensor systems may be allocated to monitor a Named Area of Interest (NAI). Once a given event occurs in that NAI, the requisite number of AHMs are emplaced in the appropriate Target Area of Interest (TAI). Designated sensor systems must be linked directly to the units which will emplace the AHM minefield(s). The unit commander is given employment parameters and is expected to employ the AHM when those parameters are met without requesting permission from corps or division. He will, of course, inform corps or division, at the first opportunity, that the AHM minefield has been emplaced.

4

(2)   Part of the IPB process is to determine the size of the helicopter threat, how that threat is likely to be employed, what air avenues of approach into the corps area of operations the threat will be most apt to take and the probable location of the forward airfields, PZs and landing zones (LZs) the threat is likely to use.   AHM TAIs will include appropriate locations along potential air avenues of approach, preferably at "choke points", and   potential forward airfields, PZs and LZs. AHM minefields will be tailored to terrain and to the size of the targeted enemy helicopter force.

(3)   On the occurrence of a specified event, or time, probably a defined enemy activity in an NAI, delivery systems are placed in the proper state of readiness, and mines are prepared.   On the occurrence of another specified event, or time, the AHMs are delivered to the designated target area.

(4)   Once deployed on the ground, each basic AHM minefield will establish its internal communications net.   If more than one basic minefield is included in the tailored minefield, those basic minefields will also net.   Netting between basic minefields may simply occur between the controller mines in each basic field.   One of the controller mines would be designated the controlling mine for the tailored minefield.   The minefield may then report to its controlling unit.

(5)   When a target is detected the AHM tailored minefield will compare that target against specified formations, or numbers of aircraft.   Engagement may commence when the first helicopter enters the first mine's engagement zone, or engagement may be delayed until an optimum number of aircraft have entered the minefield.   Engagement will then be initiated simultaneously by some portion of the mines in the field.   The remaining mines will be in a delayed engagement mode.

(6)   While the AHM minefield   may be centrally controlled by one controller mine, helicopter tracking and engagement are decentralized.   Each individual mine tracks and engages the nearest helicopter within its sensor footprint.   If target data is passed to controller mine(s), and the command to begin engagement is, in turn, passed from the minefield controller mine to all other mines in the minefield, there is no need for all AHMs in a minefield to communicate with all other AHMs in that minefield.

e. Role.

AHM will be employed in close, deep and rear operations both within the FAADS umbrella and outside the FAADS umbrella to degrade the effectiveness of enemy helicopter forces before they engage friendly forces.

(1)   Close/Rear Operations.

(a)   AHM, either MLRS, hand or VOLCANO emplaced, will both supplement and complement the Non-Line-of-Sight Forward System (NLOS) in its anti-helicopter role in close and rear operations.

(b)   AHM minefields will supplement NLOS by providing an anti-helicopter capability in those areas within the FAADS umbrella without NLOS coverage and in those areas outside the FAADS umbrella in the corps rear area.   By providing a significantly cheaper, if less capable, substitute for NLOS, AHM will enable the maneuver commander to conserve his NLOS systems, massing their fires where they can be employed to the greatest effect.

(c) AHM minefields will also complement NLOS. AHM minefields within the FAADS umbrella will not only kill enemy helicopters and disrupt enemy operations, but will also drive them into the engagement envelope of the Line-of-Sight (LOS) Forward air defense system and provide target detection for NLOS fires.

(2) Deep Operations.

AHM minefields, delivered primarily by MLRS rockets and Army TACMS and possibly by aircraft, will deny Soviet/Warsaw Pact helicopter units freedom of maneuver in that part of the corps area of operations beyond the FAADS umbrella forward of the FLOT. AHM minefields will disrupt enemy operations, render enemy helicopter forces combat ineffective through the destruction of large numbers of helicopters or drive them into the high and medium air defense (HIMAD) radar systems' LOS. Even if no HIMAD unit can engage those helicopter forces, their early detection will better enable the corps commander to prepare to defend against them and will provide him a clearer picture of the enemy commander's overall intent.

6. ORGANIZATIONAL PLAN.

AHM will be a munition. Its allocation will be based on availability and the commander's battlefield requirements expressed in a Controlled Supply Rate (CSR).

7. SYSTEM CONSTRAINTS.

a. Design.

(1) The AHM will be a member of the Army's family of Wide Area Mines (WAM) and will share common components to the maximum extent possible.

(2) AHM delivery systems will be designed so that there will be a greater than .8 probability that a given mine will be operational after emplacement in the designated target area.

(3) There will be a greater than .99 probability that an AHM minefield will have an operational controller, if such a mechanism is employed. This may require more than one "mine" in each basic minefield have the ability to control that minefield.

(4) AHMs will be electronically programmable. AHMs in both MLRS rockets and Army TACMS will be electronically programmable through an interface cable, or device performing a similar function, which connects the AHM carrying munition to the MLRS vehicle electronics.

(5) The AHM will have an operational life of no less than 96 hours (the nominal temporal extent of the corps area of operations) with a programmable self-destruct/disarm capability. An operational life of 15 days is desired. The shelf life of the AHM should be at least 10 years, with a 99% success rate, with 20 years desired.

(6) AHM will have a built-in explosive ordnance disposal capability.

b. Mobility. AHM will require no additional packaging or handling above that normally required by other WAM variants or other MLRS rocket or Army TACMS munitions.

c. Transportability. MLRS rockets and Army TACMS loaded with AHMs will meet the same transportability criteria as other MLRS rocket and Army TACMS munitions.

6

Hand emplaced AHM and AHM munitions fired from VOLCANO will meet WAM transportability criteria.

    d. **Logistics**.

        (1)   The AHM will be a "wooden round".

        (2)   AHM will have a go/no-go test for the operator.

    e. **MANPRINT**.

        (1)   **Manpower/Force Structure**. This concept will not generate new manpower requirements nor will it have an impact on force structure.

        (2)   **Personnel Assessment**. This concept will not generate new Military Occupational Specialties (MOS) nor changes in the MOS structure.

        (3)   **Training**.

             (a)   This concept will not create new doctrine. AHM employment will be consistent with AirLand and AirLand Battle-Future doctrine and will be included in otherwise existing doctrinal publications.

             (b)   This concept will require additional training for commanders and staffs, but will require only minimal, if any, additional training for maintenance personnel and operators. This concept will lead to the publication of new training documents. Maintenance instructions will be included in otherwise existing maintenance publications.

             (c)   A training device will be required to provide AHM specific technical and tactical training for operators. This device must be compatible with other systems used for force on force training, such as MILES. Additionally, AHM will be included in appropriate simulation systems' software.

        (4)   **Human Factors Engineering**. AHM will incorporate appropriate human factors engineering.

        (5)   **System Safety**. AHM will meet all applicable safety standards.

        (6)   **Health Hazard Assessment**. AHM will meet all applicable health hazard requirements.

    f. **Operational Environmental**.

        (1)   The AHM will be capable of operating year round in hot, basic and cold climatic zones per AR 70-38, day or night, in all types of weather (in which helicopters are capable of flying) without significant degradation.

        (2)   The AHM will be capable of operation with minimal degradation on terrain with slopes of up to 30 degrees.

        (3)   The basic AHM minefield will have the capability to protect itself from dismounted personnel. Execution of this capability must not result in mine self-destruction. The solution to this requirement may be the inclusion of dumb mines in an AHM basic minefield.

(4)   AHM will be capable of engaging targets through a variety of possible countermeasures, to include flares and other signature duplication devices, chaff and jamming, without significant degradation.

g. Communications.

(1)   AHM will be compatible with appropriate target acquisition, digital message, maneuver and air defense command and control and tactical and technical fire control systems -- the Army Tactical Command and Control System (ATCCS).   AHM will be in the Advanced Field Artillery Tactical Data System (AFATDS) and Forward Area Air Defense Command, Control, Communications and Intelligence System (FAADS C^3I) software.

(2)   A two way communications capability is desired, through which the AHM minefield can provide a status report and intelligence.

h. NBC Survivability. AHM is mission essential. AHM will be nuclear and chemical hardened.

8. STANDARDIZATION AND INTEROPERABILITY.

The AHM will meet all standardization and interoperability requirements. Currently, none have been defined.

9. FUNDING IMPLICATIONS.   TBD

APPENDICES:

ANNEX A - OPERATIONAL MODE SUMMARY/MISSION PROFILE (TBP)
ANNEX B - RATIONALE

ANNEX A (OPMODE SUMMARY AND MISSION PROFILE) TO OPERATIONAL & ORGANIZATIONAL PLAN FOR THE ANTI-HELICOPTER MINE (AHM)

ANNEX B (RATIONALE) TO OPERATIONAL & ORGANIZATIONAL PLAN FOR THE ANTI-HELICOPTER MINE (AHM)

Rationale for Paragraph 4. (OPERATIONAL CHARACTERISTICS):

4. a.   Means of Delivery.

Four tenets of AirLand Battle doctrine- initiative, agility, depth and synchronization, indicate that a primary means for AHM delivery will be MLRS rockets and Army TACMS.   To conform to these tenants, given the rapid tempo and chaotic nature of the AirLand Battle, requires a reliable means to rapidly emplace the AHM at depth.   Aircraft are not a reliable means of delivery for the AHM because they: lack survivability in a high mid-intensity to high intensity conflict, where the helicopter threat is the greatest; are weather dependent; and, in the case of fixed wing aircraft which are Air Force assets, may not be rapidly responsive to the needs of the maneuver commander.   Other means of delivery lack either the range or speed required for emplacement, or both.

Other means of AHM delivery are, however, desirable.   They provide the commander a certain degree of flexibility.   He will not have to commit his MLRS assets to every AHM mission and, thereby, forgo the benefit of having those MLRS systems deliver other high leverage munitions.   In cross FLOT operations conducted by Army aviation units, VOLCANO equipped helicopters or Air Force aircraft could be employed to secure the flanks and rear of those units from attack by enemy helicopter forces with AHM minefields.   Behind the FLOT, VOLCANO equipped helicopters or ground vehicles might dispense AHMs to block an ingressing or projected enemy air assault or attack helicopter force.   Hand emplacement may be necessary in the event that the other means of emplacement are unavailable.   Hand emplacement would also provide a high degree of assurance, that an AHM minefield was properly emplaced with respect to such considerations as mine LOS.

4.b.   Lethality.

"Dumb" mines are high leverage systems only when employed with other means of target attack, either observed indirect or direct fires.   They are not expected so much to kill enemy systems as to impede their freedom of maneuver.   When not "overwatched" by fires, minefields will only impede an enemy with an effective countermine capability, such as the Soviets possess, for a short period of time and will probably not damage or destroy enemy vehicles in any significant quantity.   Additionally, the requirement to reposition forces to provide "overwatching fires" inhibits the maneuver commander's flexibility.

Smart mines such as the family of Wide Area Mines (WAM), of which AHM is a member, are, on the other hand, stand-alone high leverage systems.   Stand-alone lethality is WAM's most important attribute.   WAM should be able to both delay enemy forces and/or significantly degrade their ability to fight, through destruction of enemy systems, without "overwatching fires".   Because it does not require "overwatching fires", WAM conserves forces, freeing them for employment elsewhere, greatly increasing the maneuver commander's flexibility.

4.b.(1) The majority of enemy helicopters should be flying at a height of between 5 m and 150 m above the ground.

4.b.(2) The maximum speed of some Soviet helicopters exceeds 300 km per hour.   The maximum speeds of fielded and developmental Soviet helicopters is not expected to exceed 350 km per hour.

4.b.(3) Fielded and developmental Soviet helicopters are not expected to be able to conduct evasive maneuvers in excess of 3 g in either the vertical or horizontal plane.

4.b.(4)

A .5 single shot probability of kill is a reasonable "mark on the wall". Further modeling, testing and cost benefit analysis will determine what is both achievable and cost effective.

The single shot probability of kill of individual mines is not necessarily the primary criteria by which the AHM's lethality should be evaluated. The primary target for AHM is not individual helicopters, but, rather, helicopter forces. Soviet doctrinal norms indicate that an AHM minefield should be able to destroy greater than 60% of the helicopters available to a Soviet helicopter unit. This rate of attrition, assuming an 80% operational ready rate for those units, results in only 30% of a unit remaining to accomplish its assigned mission after encountering an AHM minefield.

4.c   Target Acquisition.

4.c.(1) Self-explanatory.

4.c.(2) This will reduce the possibility of an AHM minefield's early detection and, consequently, will reduce the chance of enemy helicopters effectively employing countermeasures or avoiding the minefield.

4.c.(3) If AHM were simply employed in deep operations, the ability to differentiate between friendly and enemy helicopters might not be a required system's characteristic. Employment in close and rear operations, however, dictates an ability to identify friendly helicopters to preclude fratricide. A 99% degree of confidence is a mark on the wall which, optimally, should be achieved.

4.d.   System Operation.

4.d.(1) The ability to tailor minefield size is necessary because each engagement area will vary in size, as will the targeted enemy helicopter force.

4.d.(2) Because of the inherent mobility and agility of the helicopter, which is not bound by terrain nearly so much as a ground vehicle, an AHM minefield can achieve greater affect if it operates more like an ambush, waiting to commence engagement until the bulk of the enemy formation is in the engagement zone, rather than like a conventional minefield, which is uncovered when the first element in an enemy formation encounters the first mine in the minefield.

4.d.(3) A staggered engagement capability is necessary to reduce the number of multiple engagements of a single target. The greater the number of mines engaging a single target, the greater the probability of following helicopters being able to negotiate the minefield unscathed.

4.d.(4) Self-explanatory.

Rationale for Paragraph 5. (OPERATIONAL PLAN):

5.a.   Methodology. Self-explanatory.

12

5.b.   Responsibility.

While not delivered by air defense systems, per se, AHM is an air defense system, in so much as it performs an air defense function, just as a tank or an attack helicopter is a fire support system when employed to deliver indirect fires. Doctrinally, the employment of indirect fires provided by tanks or helicopters should be planned and coordinated with other fire support systems by the appropriate fire support coordinator. It follows, then, that AHM employment planning and coordination with other air defense systems should be conducted by the appropriate air defense coordinator.

Mine employment and fire support doctrines dictate that the corps will be the echelon of command that controls AHM employment.

a.   Mine Employment Doctrine.   Under current mine employment doctrine the corps commander would be the approval authority for the employment of AHM in the corps area of operations, regardless of the means of delivery. The corps commander may, however, delegate that authority to individual division commanders.

b.   Fire Support Doctrine.   Even if mine employment doctrine allowed the division commander to employ AHM without prior approval from the corps commander, the majority of AHM delivery systems will still be controlled by the corps commander. Corps allocates Air Force sorties to subordinate divisions. Army TACMS is a corps weapon system, although its employment may be circumscribed by higher echelon commanders. Army TACMS will not normally be allocated to divisions, although Army TACMS fires, delivered by corps artillery MLRS battalions, may be provided to divisions. Additionally, the bulk of corps MLRS assets are located in corps artillery MLRS battalions. While these battalions' fires may be allocated to a particular division, the battalions themselves may remain under corps control. Finally, the corps is the focal point for the Army's deep target acquisition systems. All this does not mean, however, that AHM fires may not be allocated by the corps commander to subordinate units.

5.c   Control.

5.c.(1) Self-explanatory.

5.c.(2) Even if all communication is lost with the minefield, the commander can still be reasonably assured that at a specified time the AHM minefield will be deactivated.

5.c. (3) While centralized control and planning is needed to insure the best employment of a resource, the AHM in this case, decentralized execution-- execution at the lowest practical level of command actually in contact with the enemy, is necessary to provide the flexibility required to react to the chaotic nature of the AirLand Battle.

5.d.   Employment.   Self-explanatory.

5.e.   Role.

The effectiveness of AHM depends on the Soviet response to its employment. Soviet doctrine emphasizes cover, concealment and deception. Even if the Soviets realized that the AHM was being employed, and knew its vertical and slant ranges, it is doubtful that they would alter their helicopter employment doctrine. By flying their helicopters at a higher altitude they would increase their susceptibility to detection, and, consequently, to attack. Detection of these helicopter forces, even if they were not

attacked, would provide friendly forces valuable tactical intelligence on the Soviet commander's concept and intent. AHM will not be everywhere on the battlefield. A less than certain chance of helicopter forces encountering an AHM minefield, coupled to a doctrinal requirement to achieve surprise, will predispose Soviet/Warsaw Pact commanders to adhere to established doctrine.

5.e.(1) Close/Rear Operations.

a. There is a need for AHM in close and rear operations. A helicopter threat is difficult to counter. By flying below radar line-of-sight (LOS) and by employing pop-up engagement techniques, helicopters can, to a large extent, render LOS air defense systems ineffective. It was for this reason that the Non-Line-of-Sight system (NLOS) was developed.

b. NLOS will complement the LOS-Forward component of FAADS, providing the combined arms team with an effective means to deal with the helicopter threat. The cost of NLOS, if not operational necessity, will, however, preclude it from being everywhere it is needed on the battlefield. It will primarily be deployed in the division forward area -- the brigade area of operations, along with the LOS-Forward system. This leaves the division and corps rear areas comparatively unprotected. AHM is needed to fill in these gaps in NLOS coverage.

5.e.(2) Deep Operations.

a. There is also a need for AHM in deep operations, to deny Soviet/Warsaw Pact helicopter units freedom of maneuver in that part of the corps area of operations beyond the FAADS umbrella forward of the FLOT. A key tenet of evolving Army air defense doctrine is the mandate to deny the enemy freedom of maneuver in the air space over his rear area of operations. While NLOS provides FAADS an effective anti-helicopter capability, no such capability exists beyond the FAADS umbrella.

b. Even if enemy helicopter forces, operating beyond the FAADS umbrella, fly within the envelope of air defense radars, high and medium air defense systems (HIMAD), while capable of engaging helicopters, may not do so. While HIMAD systems have the ability to engage helicopter targets beyond the FLOT, they may, at least in the initial stages of a conflict, have higher priority targets to engage such as high performance aircraft and tactical missiles.

c. There is also the problem of target acquisition and engagement. Because it is standard operating procedure for Soviet/Warsaw Pact helicopter forces to move along covered and concealed air avenues of approach, flying at low altitudes, it will be difficult for air defense radars to acquire them before they engage friendly forces. Even if these helicopter forces are detected, and HIMAD fire units are available, the engagement windows could prove too fleeting for successful engagement.

d. Although rocket and missile artillery has the range to attack enemy helicopter forces beyond the FAADS umbrella, it does not pose a major threat to those forces. Unless helicopters are attacked while either hovering or on the ground, conventional artillery fires will probably not have a significant impact on them because of their inherent mobility and agility.

e. As with artillery, Army Aviation and Air Force assets do not pose a major threat to enemy helicopter forces. There are two main reasons for this. First, at least in the initial stages of a conflict, the majority of Air Force assets, like HIMAD systems, will probably be involved in the counterair battle. Secondly, neither Air Force assets nor Army Aviation can be expected to successfully conduct cross-FLOT operations against a

coherent, modern air defense without a significant Suppression of Enemy Air Defense (SEAD) effort. The SEAD effort will be difficult to implement, particularly in the initial stages of a conflict, because of other demands on corps fire support assets. Fire support is crucial to the successful conduct of SEAD in the corps area of operations.

Rationale for Paragraph 7. (SYSTEM CONSTRAINTS):

7.a.   Design.

7.a.(1) Economics dictates that AHM should have as much commonalty as possible with the other members of the WAM family.

7.a.(2) A .8 probability that a given AHM will be operational after emplacement is a reasonable "mark on the wall" that may change as further modeling, testing and cost benefit analysis indicate what is both achievable and cost effective.

7.a.(3) If a controller mine is employed there must be an almost certain probability that an AHM minefield will have an operational controller mine.

7.a.(4) The chaotic nature of the AirLand Battle dictates a means of rapidly reprogramming an AHM to meet a changing situation.

7.a.(5) Once again, a minimum operational life of 96 hours is a "mark on the wall", based on the assumption that AHM will be a corps asset. Further modeling, testing and cost benefit analysis will indicate what is both achievable and cost effective, in· this regard.

7.a.(6) Self-explanatory.

7.b.   Mobility.   Self-explanatory.

7.c.   Transportability.   Self-explanatory.

7.d.   Logistics.   Self-explanatory.

7.e.   MANPRINT.   Self-explanatory.

7.f.   Operational Environment.

7.f.(1) If enemy helicopters can operate in a cold climatic zone there is a need for AHM to operate in a cold climatic zone.

7.f.(2) The requirement to operate on a 30 degree slope is also a "mark on the wall", based on WAM requirements. Further modeling, testing and cost benefit analysis will indicate what is both achievable and cost effective, in this regard.

7.f.(3) Self-explanatory.

7.f.(4) Self-explanatory.

7.g.   Communications.   Self-explanatory.

7.h.   NBC Survivability.   Self-explanatory.

MODELING AND ANALYSIS
FOR THE
ANTI-HELICOPTER MINE

Introduction

This presentation will discuss the objectives of the modeling and analysis, some useful tools and techniques, preliminary results, and some suggested further research needed to develop the most effective anti-helicopter mine weapon system.

1.   Objectives, Tools and Techniques

OBJECTIVES OF MODELING

1. DETERMINE SIZE OF MINEFIELD

2. DETERMINE NUMBER OF MINES IN FIELD.

3. DETERMINE SINGLE SHOT Pk OF MINE.

4. ESTABLISH MINEFIELD COMMUNICATIONS REQUIREMENTS AND MINE LOGIC.

MODELING TOOLS AND TECHNIQUES

1. THREAT HELOCOPTER PERFORMANCE AND DOCTRINE.

2. U.S. AIR DEFENSE DOCTRINE AND MINE DELIVERY SYSTEMS.

3. STATIC STATISTICAL ANALYSIS.

4. DYNAMIC MINEFIELD SIMULATION.

5. THEATER TERRAIN ASSESSMENT.

It is essential that the performance requirements of the anti-helicopter mine and minefield be established, and the essential parameters include: 1) the size of minefields to be employed; 2) the number of mines in each field; 3) the lethality of the mine; and 4) minefield intelligence necessary to take full advantage of the first three parameters. Tradeoffs between these parameters must be investigated to assure that the system is going to do its job cost effectively.

To properly perform the analysis, scenarios have to be developed based on threat doctrine and helicopter performance with respect to our air defense doctrine and mine delivery systems. We cannot just throw these mines out on the battlefield and hope the enemy runs into them. Basically, we have to understand how the enemy operates, and what his capabilities are. Then we have to evaluate how we operate, and what existing resources support us. In this manner, we will find where the

anti-helicopter mine fits into combined arms operations, and how it can deliver the greatest blow to threat helicopter forces.

This presentation will concentrate on the statistical and simulation models used to perform the preliminary tradeoff analysis, and will talk about the need for a theater terrain assessment of candidate geographical regions of employment for the anti-helicopter mine.

2. Theater Terrain Assessment

THEATER TERRAIN ASSESSMENT

QUANTIFY SUITABILITY OF MINE TO THE THEATER
OF OPERATIONS.

A. Identify nap-of-the-earth air avenues of
approach for squadrons and regiments

B. Characterize avenue depths and widths

C. Identify forests, rivers and built-up areas

ESTABLISH MINEFIELD SYSTEM REQUIREMENTS

A. Mine effective range and altitude

B. Minefield dimensions and number of minefields

C. Density of minefield

The theater terrain assessment is critical to developing an effective anti-helicopter mine system. This is a three dimensional battlefield and the traditional concepts of mine warfare and counter-mobility may not be adequate. The system will have limitations that are terrain dependent and early realization of these problems will ensure designs which minimize any impact on effectiveness. The terrain assessment will give quantitative and qualitative support for choosing design parameters such as mine effective range and employment parameters such as the size and number of minefields and the mine density within minefields.

The following five pictures show that despite a commander's best efforts at locating and channelizing the enemy helicopters, finding chokepoints, and getting the mines emplaced, he could find himself in very embarrassing positions should the subtle impacts of terrain not be assessed. Just as bad, he could find he has an asset that cannot be deployed in his area of operations because it is terrain limited, but is a considerable logistics burden that he has had to pack around with him.

2

3.   Assess: Multiple Air Avenues of Approach

ASSESS:
MULTIPLE AIR AVENUES OF APPROACH

MINEFIELD

OBJECTIVE
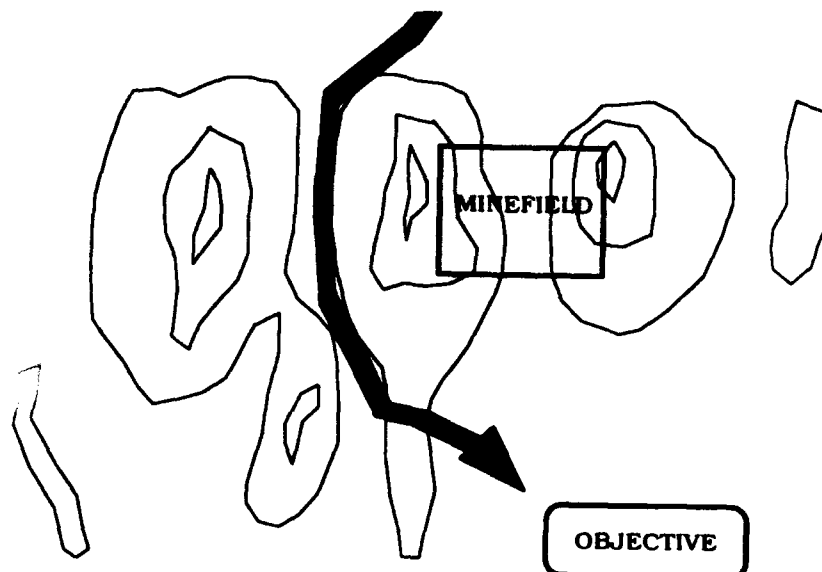
Should the commander identify a worthwhile threat, he should
have the resources to deliver enough mines and minefields to get
a reasonable shot at interdicting that threat.   In this example,
there are perhaps three or four possible chokepoints and nap-of-
the-earth air avenues of approach to the objective (assuming that
has been correctly identified).   With this much airspace, one
minefield cannot really be expected to impede the threat.

4:    Assess: Line-Of-Sight Obstructions Along Air Avenues of
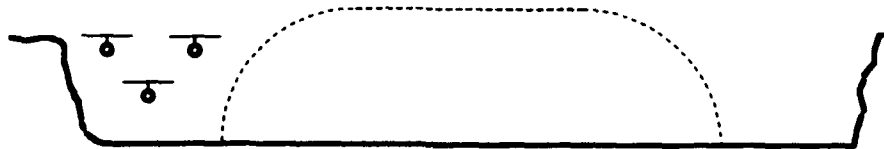   Approach

ASSESS:
LINE-OF-SIGHT OBSTRUCTIONS ALONG
AIR AVENUE OF APPROACH
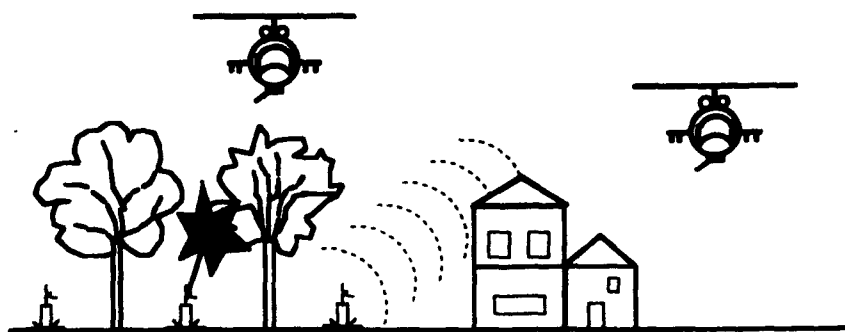
If fire control systems and seekers are hampered by foliage and built up areas, and if there are too many obstructions to the line-of-fire, the system should not be placed in that location. The flip side to this requirement is then how many suitable, cleared locations exist in the theater of operations?

5.   Assess: Air Avenue of Approach Too Wide for Minefield

ASSESS:
AIR AVENUE OF APPROACH TOO WIDE
FOR MINEFIELD

Although we may be able to identify the avenue of approach, there is going to be a lot of slack in the formation's exact flight path.

6.   Assess: Air Avenue of Approach Too Deep For Effective Altitude of Mine

ASSESS:
AIR AVENUE OF APPROACH TOO DEEP FOR
EFFECTIVE ALTITUDE OF MINE

4
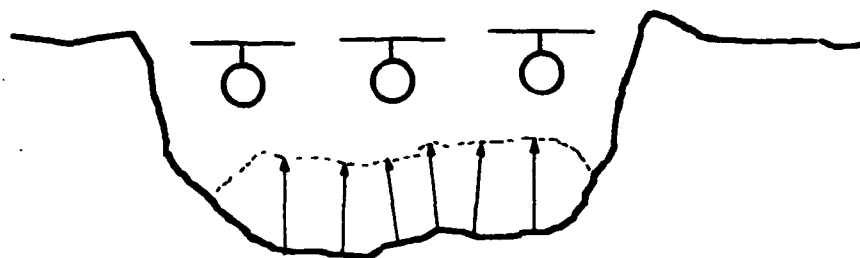
Although we believe that the threat will fly 50 meter nap-of-the-earth, this cannot be considered rigid doctrine. Flying just below the military crest may be adequate to avoid detection, and safer in this case.

7. Assess: Air Avenue of Approach Is Over a River or Lake

**ASSESS:
AIR AVENUE OF APPROACH IS OVER
A RIVER OR LAKE**
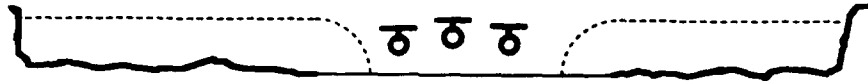
Unless these mines float (with an anchor), or have considerable range, bodies of water can be dead space to the anti-helicopter mine. Rivers also tend to be in ideal air avenues of approach, since geologically most canyons and valleys are cut by rivers. It is also natural to expect trees and foliage along river banks. Of course, river and lake widths vary with geography and the rainfall season, and there are variations with the width of suitable, flat river banks. This also brings up the consideration of any ground slope angle limitations on the mine and minefield. It is not realistic to expect valley floors to be exceptionally flat and clear of tall grass, large rocks, or fallen debris, which may upset the placement of the mines.

This theater terrain assessment has not been performed, to our knowledge, for any potential area of employment for the anti-helicopter mine. Although, relevant terrain analysis may have been performed for the Wide Area Mine (WAM), and there may be useful air defense studies available, as well. We are developing a methodology for performing the theater terrain assessment, and it will involve extensive map analysis. Other than saying that it may be very tedious, I cannot really report on any developments at this time.

8. Doctrinal Considerations

DOCTRINAL CONSIDERATIONS

1. Threat helicopters fly in formations, which are terrain and mission dependent. Formations may be both long and narrow and wide and short.

2. Formations fly nap-of-the-earth to avoid detection, about 50 meters above ground.

3. Minefield must achieve surprise on the entire formation, else threat may take evasive action: stopping, turning around, pulling up out of range.

4. Minefield must be wide enough to cover the entire air avenue of approach, and long enough to engage the entire formation simultaneously.

5. Battle dynamics require rapid minefield emplacement -- Volcano (air.ground) and artillery (MLRS, ATACMS) delivery -- random, uniform patterns.

The SPC study team prepared a "Concept for the Anti-Helicopter Mine (AHM)," which forms the basis for the above doctrinal considerations, which impact on the analysis ·of minefield effectiveness. Familiarity with this document will make understanding these considerations a little easier. However, I will briefly discuss each item listed here.

The variability in the size and dimensions of threat helicopter formations adds complexity to the analysis. Exhaustive investigation of all possible combinations and likelihood of occurrence was not reasonable within the effort of this study. Therefore, we will concentrate on two extreme conditions: 1) long and narrow; and 2) wide and short. Minefield effects on intermediate formation dimensions should fall between these two extremes.

All formations and helicopters flying at fifty meters above the ground (or tree tops) is another modeling simplification. In reality, precise altitudes will vary within several meters about an average formation altitude, which will also vary with how well the formation can fly nap-of-the-earth. With respect to mine range and formation evasive actions, the formation altitude is a critical parameter in the effectiveness analysis and should be varied for sensitivity effects. Within this study effort, only a fifty meter formation altitude was used.

The need for the minefield to achieve surprise and be long enough to engage the entire formation simultaneously is a consideration that goes beyond the traditional uses of minefields. In the past, when placing anti-tank and anti-personnel minefields, the purpose was to impede passage over

6

certain terrain and to inflict nominal casualties. The ability or psychological threat of the minefield to inflict casualties was the real weapon used to impede the enemy. We really expect that after the first mine is tripped, the armor and infantry will pause to assess the situation and then begin the time consuming task of clearing a lane or finding a way around. We place lots of relatively cheap mines in the field to ensure that there are prohibitive casualties should the enemy decide to run the minefield, and we cover the minefield with deadly fire to further harass attempts to cross. Basically, the aims of the minefield are achieved if it kills nothing and the enemy is impeded, and if it does kill something, all the better. The low cost of a traditional minefield is worth this benefit.

With a relatively more expensive anti-helicopter mine system, and given the speed and flexibility with which helicopters can maneuver, the achievement of casualties becomes the minefield's most significant purpose. Without stand-alone lethality, denying certain nap-of-the-earth airspace to a helicopter formation may be a two minute inconvenience. If the airspace above the minefield is not covered with air defense assets, the threat might not even care about the minefield and fly above it in the clear.

This, of course, assumes that the threat knows the minefield is out there. If the helicopter formation is very long, and some can stretch up to a kilometer and a half in length, should the minefield start firing at the lead helicopter, the others will find out very quickly and begin evasive action prior to entering the minefield. They may take a few casualties, as with ground forces and the traditional minefield. However, unlike the traditional minefield, their losses and inconvenience may not be close to our costs and logistics burden of emplacing the minefield. For these reasons, the minefield must have some capability to hold fire until the formation is unwittingly in the kill zone, and large enough so that attempts at evasive action will be futile. Some helicopters will always escape, however, they should be the exception to the case.

Because of highly dynamic battle conditions, especially when trying to interdict helicopters, minefields will have to be emplaced rapidly. The artillery, air, and ground systems which do this most effectively are mine scattering systems. This complicates analysis slightly, since it means that there is not precise knowledge of mine locations, and tailoring minefield densities limited. The result is that the analysis is dealing with random, uniform minefield patterns and densities. To account for this characteristic in simulation models, random number generation is used to create the minefield. In statistical models, density distributions are used. The end result is that there will always be more or less mines engaging the formation rather than some exact number.

7

9. Zoom-Out Evasive Action

ZOOM-OUT EVASIVE ACTION
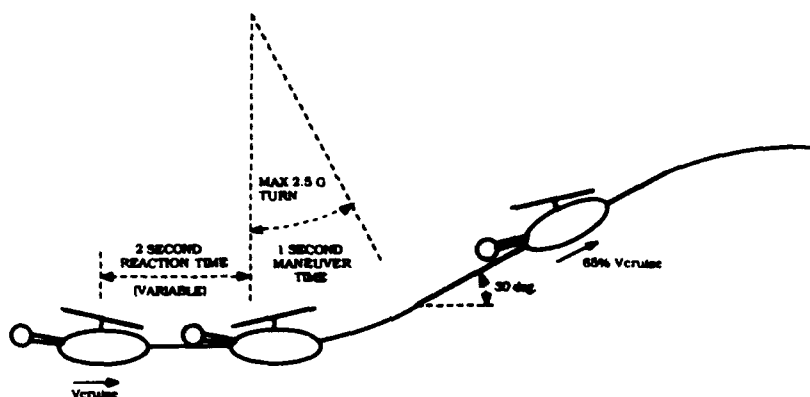
Helicopters are high value, limited assets. Therefore, it is unrealistic to expect the Soviets to just run the gauntlet of an anti-helicopter minefield. If there is a way out, they will exploit it and train their pilots to do it.

There are limitations, however, to the options available to large numbers of helicopters flying tight formations at high speed. They could try and stop, but coming to a hover at high speed takes time and the formation will slide right into the minefield anyway. If the minefield is ambushing the entire formation, as it should, stopping or beginning a formation turn will keep it in the minefield, all the same. The really effective option is to pull up and out of range as fast as possible. The maneuver is called a zoom in Soviet literature. We've called it a zoom-out in this context. This is the most likely evasive action we believe the Soviets will take when they encounter an anti-helicopter minefield.

The maneuver involves changing the rotor pitch and collective so that the relative wind speed creates a burst of lift at the expense of the forward velocity of the helicopter. The thirty degree climb angle was chosen as a compromise between the acceleration loads on the hub (most can take no more than

8

three g's) and the pilot's ability to stop the zoom short of flipping the helicopter or losing too much speed. When performed correctly at cruising velocities, the helicopter will take a kind of roller coaster ride upward at considerable speed.

Some of the issues to be investigated with this zoom-out maneuver include: the reaction time of the pilot in realizing there is a minefield firing on the formation; and the limitations placed on zooming-out while in formation, specifically, avoiding mid-air collisions with other helicopters zooming-out slightly off-angle or a little late. This analysis only looked at the parameters presented in the picture, and all helicopters performed it simultaneously.

10. Minefield Dimensions

MINEFIELD DIMENSIONS

Balance:

1. Available mine and delivery assets

2. Terrain and number of possible air
   avenues of approach

3. Helicopter threat

4. Size of desired catch (don't be greedy)

Considerations:

1. More smaller fields may be better than one large one.
   You do not want to commit everything and miss.

2. Wearing down the threat with multiple smaller
   engagments may be more successful than trying to
   wipe him out with one massive attack.

3. Once a minefield is discovered, it may be easily neutralized

These are the major issues and concerns the commander will deal with when deciding how large a field should be committed and how many mines should be emplaced in any one minefield. These issues, when combined with threat doctrine, give an indication of what formations and minefields should be analyzed in the model.

11. Typical Squadron Formations

TYPICAL SQUADRON FORMATIONS
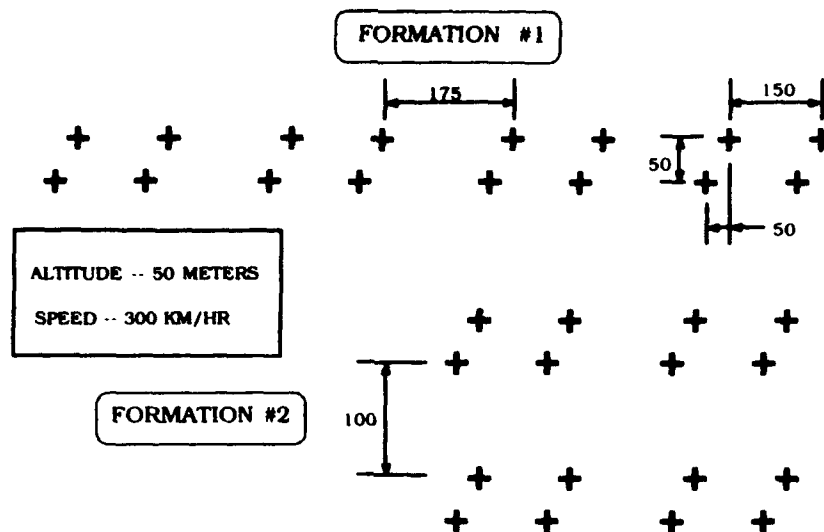
Jumping ahead, just a little, we've identifying a squadron size formation (16 to 20 helicopters, depending on readiness) ·as the appropriate "catch" for the anti-helicopter minefield. Formation #1 is the long and narrow one, and #2 is the short and wide formation.

12. Minefield Size in This Analysis

MINEFIELD SIZE IN THIS ANALYSIS

For the purposes of this analysis, the standard mine field size is 1000 meters x 1000 meters.

Rationale:

1. The anti-helicopter mine is a Corps asset, although it may be allocated to a Division.

2. At the Corps and Division level, interest is in the deployment of threat helicopter regiments (48 helos in 4 squadrons of 16 @ 80% readiness).

3. The squadron is the basic maneuver unit within the regiment, so the desired catch should be no larger than a squadron of 16 helos.

4. The typical squadron formations (#1 and #2) are 1325 m and 575 m in length, respectively. A 1000 m long mine field is a good compromise for both formations.

5. The width of the field depends on the terrain and finding a suitable choke point in the air avenue of approach. This analysis assumes 1000 m to allow for complete washing of the formation if it misses center.

The rationale for these formations, as well as the typical minefield size is based on the discussion of U.S. and Soviet doctrine, presented in the "Concept for the Anti-Helicopter Mine", and a theater terrain analysis. Since the terrain analysis is not yet available, we made an educated guess and made the minefield width 1000 meters. This also matches conveniently with the minefield length, which should be proportional to the formation lengths. Again, as with the variability in formation dimensions, the minefield dimensions are completely flexible. However, an exhaustive study is not possible at this time, and we feel this minefield size is a good indication of overall system capabilities.

13. Minefield Employment Flexibility

MINEFIELD EMPLOYMENT FLEXIBILITY

Given:

1. Threat helicopters number about 4000, or 250 squadrons of 16.

2. Mine procurement about $1 billion, @ $10,000 each yields 100,000 mines.

3. A 1000m x 1000m minefield, averaging 150 mines each yields 667 minefields.

4. This breaks out to about 2.7 minefields per squadron.

Given the size of the typical minefield and the number of threat squadrons, we feel the scenarios within this analysis retain the deployment flexibility that the system will need in the field. There are many air avenues of approach and suitable choke points in a theater of operations. However, the number which is suitable to squadron size formations must inherently be less than the number available to smaller flights or single helicopters. Additionally, the cost of the minefield is leveraged against the cost of a larger number of helicopters. However, there is an upper limit on how many helicopters we reasonably expect to catch in the minefield. Although the Soviets may maneuver two or more squadrons as one formation group, it is unlikely, since such a formation becomes an attractive target to other air defense systems. A final point is where suitable, long range, high volume mine delivery systems are located in U.S. forces. The anti-helicopter mine is best suited to the Corps and Division level, which has control over the delivery assets, and this level is interested in the movements of significant numbers of threat forces, in this case helicopter squadrons.

11

14. Static Statistical Model

STATIC STATISTICAL MODEL

A. Quickly assesses tradeoffs between:

   Minefield dimensions
   Number of mines in field
   Mine Single Shot Pk (SSPK)
   Number of helicopters passing through minefield
      and helicopter formation effects

B. Assumes near perfect communications among mines

   Shoot-Look-Shoot
   Kill is assessed before target is re-engaged

C. Gives upper limit on expected performance
   (Tends to over predict number of kills)
   Assumes all mines in lane can shoot at all
   helos in lane.

Prior to beginning work on a simulation model, we first looked at developing a quick and clean statistical model to get a feel for the level of importance for various system parameters. The model has limitations, however, because it does not account for the distribution of helicopters within the formation dimensions. The helicopters also displace during an actual engagement, and the statistical model does not account for this effects either. Nevertheless, the model shows interesting tradeoffs among mine lethality, mine range, and number of mines in the minefield, and emphasizes the variability in minefield effectiveness with respect to the formation widths. Results for this model are presented later.

The next three figures describe the model algorithm and the supporting mathematics.

15. Static Model Algorithm

STATIC MODEL ALGORITHM
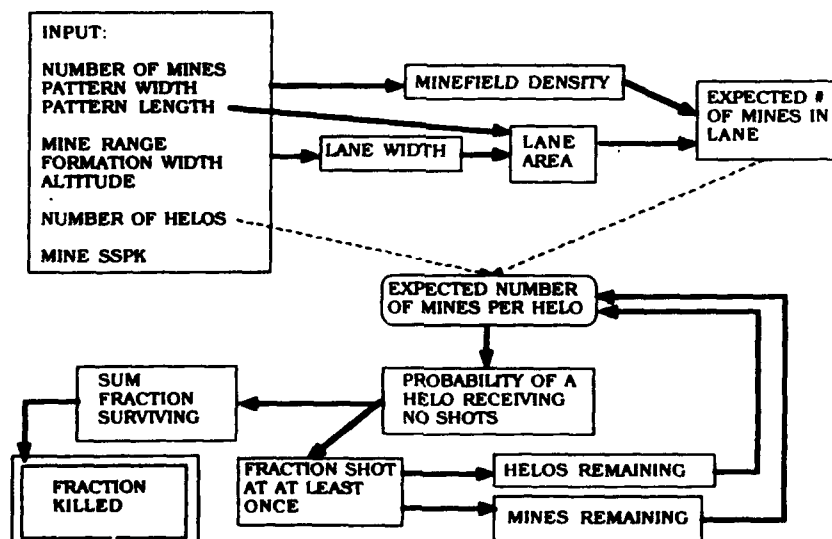
16. Static Model Mathematics

STATIC MODEL MATHEMATICS

LANE AREA: ⟵ MINEFIELD
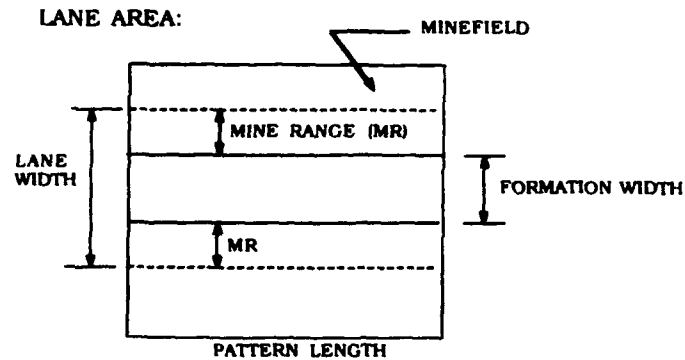
The lane width is greater than the formation width because of the
range of the mine. however, formation altitude (H) slightly reduces
this width extension:

Lane Width = Formation Width + 2 (MR^2 - H^2)^.5

Lane Area = Lane Width x Pattern Length

17. Static Model Mathematics

STATIC MODEL MATHEMATICS

PROBABILITY OF A HELO RECEIVING NO SHOTS:

u = expected number of mines per helo = #M/#H

P(0) = u^0/0! (e^-u) = e^-u   (Poisson's Distribution)

This probability is the fraction that is no longer
shot at, or the fraction surviving. The fraction shot
at at least once is one (1) minus the fraction surviving.

MINES REMAINING

The mines remaining after each firing iteration is the
number of mines before the firing, less the number
of helos shot at during the iteration.

FRACTION REMAINING

After firing the mines, the helicopters remaining are
calculated using the survival rule:

Ps = (1-SSPK) ; since each mine-helo shot is an
independent event, the percent of helicopters surviving
the fire is this probability of survival.

13

18. Dynamic Simulation Model

DYNAMIC SIMULATION MODEL

A. Generates random, uniform minefield patterns, models precise mine locations

B. Models exact helicopter locations within formations helicopter speed, heading, and altitude.

C. Assesses kill using random number generation and mine Single Shot Pk.

D. Models minefield logic, such as hold fire and volley fire.
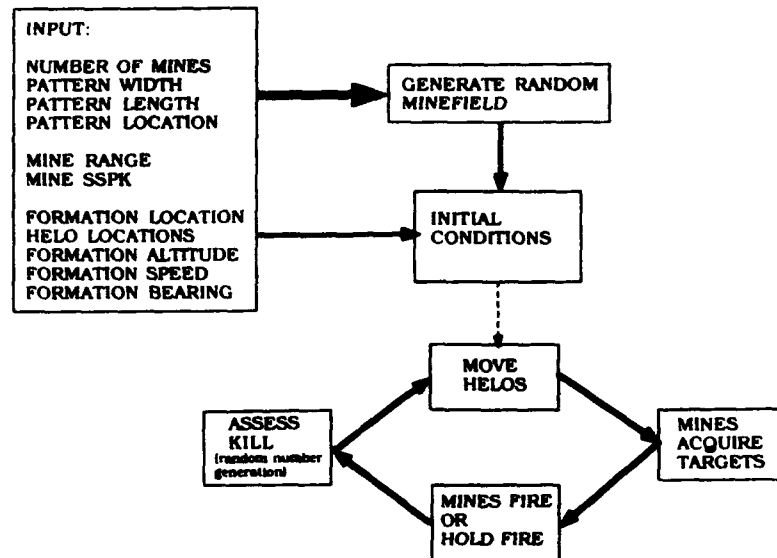
E. Models helicopter evasive actions.

F. Requires many iterations to converge on answer.

The simulation model allows great flexibility to study the effects of command and minefield logic factors, the effects of moving formations and helicopter evasive actions, and various minefield patterns and shapes. Although, for the purposes of this study only certain patterns and formation parameters were investigated, as mentioned earlier, despite the complete flexibility in the model. The model, of course, never gives the same result twice, so many iterations must be performed to find where the average expected fractional coverage converges. This is not necessarily a drawback in the analysis, since the minefield, when actually employed will not perform exactly the same way every time either. As a result, just as important as finding the average performance, is analyzing the performance distribution about the mean level of effectiveness. By doing this, a minimum minefield performance specification can be written, which ensures that every time the minefield is used it will kill a minimum amount of helicopters. This information helps in planning overall force effectiveness and the commitment of contingency weapons systems to the battle. On the other hand, if a minimum specification of 60% kills is required for the systems, an average level of performance of 80% may be required, since sometimes more or less helicopters will get through. I mention this now, prior to showing the model results, because these results are presented as average performances without standard deviations. Presenting this additional information is too cumbersome at this time.

19. Simulation Model Algorithm

SIMULATION MODEL ALGORITHM

```
INPUT:                          ┌──────────────────┐
                                │ GENERATE RANDOM  │
NUMBER OF MINES          ──────>│ MINEFIELD        │
PATTERN WIDTH                   └──────────────────┘
PATTERN LENGTH                          │
PATTERN LOCATION                        ↓
                                ┌──────────────────┐
MINE RANGE                      │ INITIAL          │
MINE SSPK                       │ CONDITIONS       │
                         ──────>│                  │
FORMATION LOCATION              └──────────────────┘
HELO LOCATIONS                          ┊
FORMATION ALTITUDE                      ↓
FORMATION SPEED                 ┌──────────────────┐
FORMATION BEARING               │ MOVE             │
                                │ HELOS            │
                    ┌───────────┴──────────────────┴──────────┐
            ┌───────────┐                           ┌─────────────┐
            │ ASSESS    │                           │ MINES       │
            │ KILL      │                           │ ACQUIRE     │
            │(random number)│                       │ TARGETS     │
            │ generation)│                          └─────────────┘
            └───────────┘      ┌──────────────┐
                               │ MINES FIRE   │
                               │ OR           │
                               │ HOLD FIRE    │
                               └──────────────┘
```

The input and methodology of the model is straightforward. Basically, the model moves the helicopters at a discrete time step. Then the mines acquire targets. At this point, some decision logic is needed in the mine, if multiple targets are within range. This model decides that the mine will fire at the closest target. There is additional command logic that decides if each mine should fire at will or hold fire for some reason. This is where the opportunity is for staging a minefield ambush, as well as creating other fire control schemes. When the decision is that the mine will fire at its target, a random number is generated and evaluated against the mine's SSPK to see if there is a kill. Finally, when there is a kill, the helicopter is no longer targetable and no longer moves. Associated kill and miss data is stored for later analysis.

20. Static Model Results

STATIC MODEL RESULTS

FORMATION #1   16 HELICOPTERS   FORMATION WIDTH 50 METERS   ALTITUDE 50 METERS

MINE PATTERN 1000x1000

MINE RANGE 100 METERS

LANE WIDTH 223 METERS

SSPK\MINES	50	100	150	200	
.30	.2093	.4185	.6278	.8340	FRACTION KILLED
45	.3139	.6190	.8255	.9221	
60	.4121	.7136	.8665	.9359	

MINE RANGE 150 METERS

LANE WIDTH 330 METERS

SSPK\MINES	50	100	150	200	
30	.3120	.6240	.8074	.9740	FRACTION KILLED
45	.4678	.8229	.9484	.9828	
60	.5819	.8636	.9545	.9843	

MINE RANGE 200 METERS

LANE WIDTH 437 METERS

| SSPK\MINES	50	100	150	200	
30	.4100	.8191	.9720	.9944	FRACTION KILLED
45	.6078	.9169	.9817	.9956	
60	.7046	.9312	.9833	.9958	

Looking at model results now, this table of performance was generated using the static model and formation #1 (the narrow and long formation). As intuitively expected, minefield performance improves directly with an increase in all three parameters of mine range, number of mines, and mine SSPK.

21. Static Model Average Results and Trends

STATIC MODEL AVERAGE RESULTS AND TRENDS

16
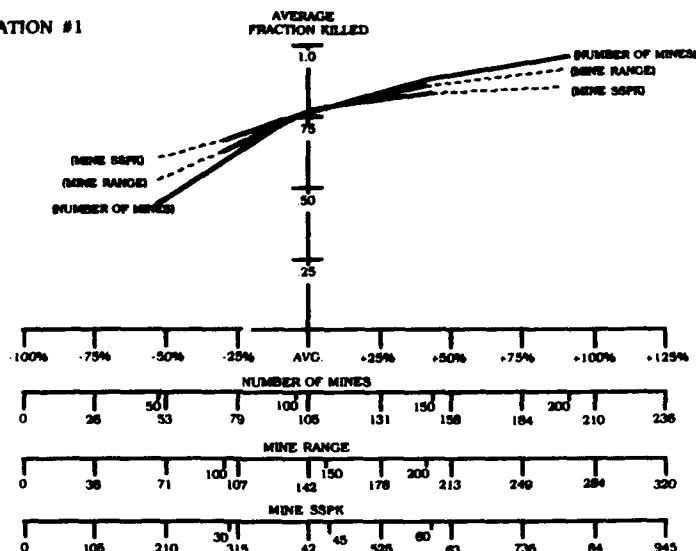
The previous table of data, however, does not clearly show the tradeoffs between the three parameters. The tradeoffs are important when trying to decide the cost effectiveness of increasing any one parameter over another, as well as which parameter can be reduced with the least impact on overall performance. The data has been manipulated by averaging the results for each parameter value. In other words, for example, all the results for the SSPK=.3 were averaged separately. Then the SSPK=.45 results were averaged, etc. To present the trends of each parameter against the same proportional increase or decrease, the horizontal axis shows percent increases above and below the value of the parameter which corresponds to the overall board average. In other words, the value of the number of mines in the field which gives the total board average of about .76 average fractional kills is 105 mines. What this means is that given 105 mines in the field, and a spread of SSPK from .3 to .6, and a spread of mine ranges of 100 to 200 meters, the average results for a minefield of 105 mines is this board average. The average results for the average level of mine range and SSPK is exactly the same average value -- the board average. This average value does not necessarily correspond exactly with a parameter value used in the analysis. These values fall left and right of the average, and the average results for each parameter value is plotted to give the curve. The result is that trends in SSPK, mine range, and number of mines can be observed with respect to these parameters' average influence on minefield performance.

The interpretation of the curves for this model is that above these average parameter values (105 mines, 142 meter mine range, and .42 SSPK) the minefield performance increases faster for every percent increase in number of mines. This trend is incrementally less for mine range and mine SSPK. Curiously, the reverse is true when decreasing parameter values below the average levels. The utility of these curves is that the costs of incremental increases in each parameter can be evaluated against the effectiveness increase, and one can begin to objectively address system specifications and requirements.

A few words of caution, however, are needed. These curves portray a wide spread of data that underwent a lot of averaging. This is useful, and necessary, when beginning from scratch to get a feel for the big picture, so to speak. As parameters become better defined, and cost factors better assessed, one should begin to look closer at smaller sections of the overall performance board and generate curves for these smaller sections, where the extreme tails of the data are less influential. This will help decrease the possibility of confirming an erroneous hypothesis about the tradeoff performances. In the context of this preliminary study, therefore, these charts and tables are not the final word. Rather they highlight the methodology used and provide some initial insights to the problem.

22. Dynamic Model Results

DYNAMIC MODEL RESULTS

FORMATION #1 16 HELICOPTERS   FORMATION WIDTH 50 METERS   ALTITUDE 50 METERS

MINE PATTERN 1000x1000   MINEFIELD HOLD-FIRE UNTIL FORMATION AT FAR END
                                NO VOLLEY-FIRE DELAY

MINE RANGE 100 METERS

MPK	50	100	150	200	
30	1913	3731	4960	6060	FRACTION KILLED
45	2938	4771	6675	7563	
60	3729	6017	7459	8521	

(30 ITERATIONS EACH)

MINE RANGE 150 METERS

MPK	50	100	150	200	
30	2531	4888	5904	6792	FRACTION KILLED
45	3563	5489	7354	7896	
60	4521	6663	7694	8354	

MINE RANGE 200 METERS

MPK	50	100	150	200	
30	3417	5000	6417	6960	FRACTION KILLED
.45	4417	6437	7396	7709	
.60	5125	7106	7875	8206	

The simulation was run using Formation #1 again. The minefield commands were set so that the minefield would hold fire until the lead helicopter was at the far end of the minefield. Because the formation was longer than the field, the last flight of four helicopters had not yet enter it. The helicopters performed no evasive action and just charged on through the minefield. As discussed earlier, this is probably are rare event. The rationale for the ambush has been discussed earlier.

Comparing these results to the static model shows a significant reduction in minefield performance, especially with the higher parameter values. The average results and trends are presented in this next figure.

23. Dynamic Model Average Results and Trends

DYNAMIC MODEL AVERAGE RESULTS AND TRENDS
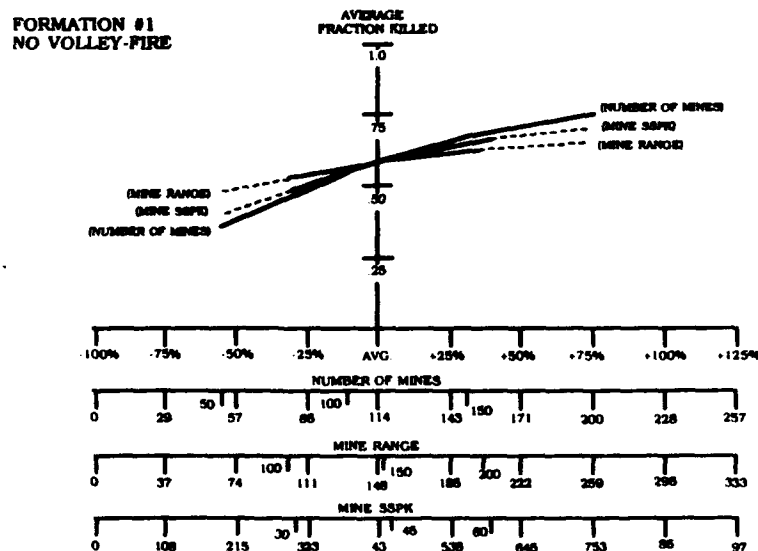
Interestingly enough here, the tradeoff trends between mine SSPK and mine range reverse from those of the static model. This is true for all simulation here out.

24. Dynamic Model Results

DYNAMIC MODEL RESULTS

FORMATION #1   16 HELICOPTERS   FORMATION WIDTH 50 METERS   ALTITUDE 50 METERS

MINE PATTERN 1000x1000   MINEFIELD HOLD-FIRE UNTIL FORMATION AT FAR END
ODD-EVEN VOLLEY-FIRE DELAY 5 SECONDS

MINE RANGE 100 METERS

	50	100	150	200
30	2167	3646	5583	6625
45	3186	5646	7334	8750
60	3687	6979	8709	9396

(30 ITERATIONS EACH)

MINE RANGE 150 METERS

	50	100	150	200
30	2709	5292	7339	8821
45	4187	6750	8438	9663
60	5292	8417	9468	9792

MINE RANGE 200 METERS

	50	100	150	200
30	3771	6042	8229	8771
45	4896	8146	9333	9834
60	5896	8854	9917	9937

After reviewing the poor performance of the minefield in the previous scenario compared to the static model, we noticed one peculiarity in the simulation output. That is that often a helicopter was fired on numerous times simultaneously (often up to 8 times) and that kills were assessed multiple times, as well. It also turned out that not all helicopters were in range of mines or the closest to at least one mine. Shots were, therefore, simply wasted. It is obviously not an effective fire control method to have all mines fire at will simultaneously.

In this scenario, therefore, an odd or even tag was placed on each mine in the field. Even numbered mines fired in the initial volley, and odd numbered mines fired .5 seconds later. The purpose was to assess kills, then fire on surviving helicopters with a reserve of mines. The results dramatically improve, however, not to the level of the static model. This is undoubtedly because the static model assumes all mines in the lane can fire at all helicopters in the lane, and this is just not the case. A mine that can just reach a helicopter on one flank will not fire if that particular helicopter is taken out earlier by a closer mine. The static model could be improved to account for this, and possibly it should for quick analyses, but it was forgone at this point in the study.

19

25. Dynamic Model Average Results and Trends

DYNAMIC MODEL AVERAGE RESULTS AND TRENDS
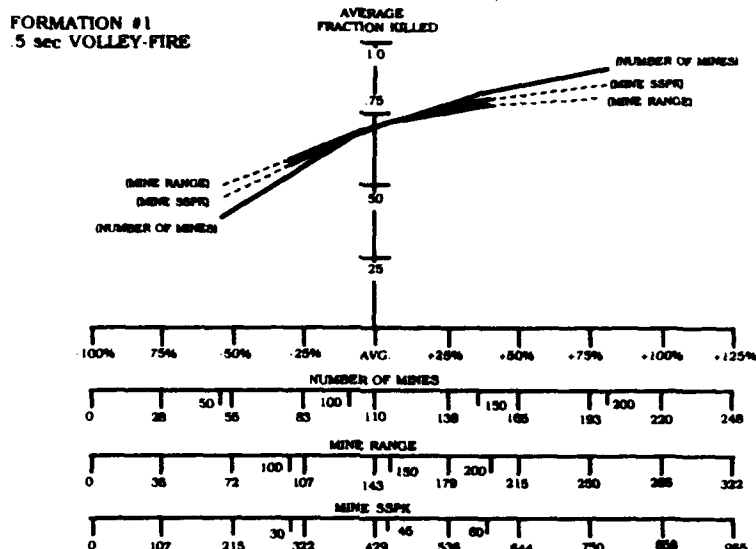
These curves show the average trends for the volley-fire scenario for Formation #1 (the long and narrow formation). There is nothing really spectacular to note here.

Some comments are warranted, however, on the effective use of volley-fire. That is, can a mine or minefield really assess a kill? How does a mine know that what it is tracking has already been fired on and critically damaged, so that it does not fire on it again? In the simulation, there was no doubt. In reality it may take several seconds (perhaps up to 3) for a helicopter moving at cruising speed at fifty meters height to impact the ground should it experience complete turbine failure. In three seconds at cruising speeds, helicopters which have survived the initial volley will have zoomed-out or charged on through the minefield. The .5 second delay in this run is not some special number. It was a first try at volley-fire, and obviously the realities of it need to be investigated.

A related issue to volley-fire is the potential of killed helicopters to destroy non-fired mines on the ground. The catastrophic detonation of a fully armed and fueled helicopter will discharge a large blast, and even if the helicopter does not explode, falling debris will cover a large crash area and could wipe out live mines on the ground. These issues need evaluation, as well.

26. Dynamic Model Results

DYNAMIC MODEL RESULTS

FORMATION #1   16 HELICOPTERS   FORMATION WIDTH 50 METERS   ALTITUDE 50 METERS

MINE PATTERN 1000x1000   MINEFIELD HOLD-FIRE UNTIL FORMATION AT FAR END
                                   NO VOLLEY-FIRE DELAY 2.0 SECOND ZOOM-OUT DELAY

MINE RANGE 100 METERS

SSPK	50	100	150	200
30	1979	3438	4271	5333
45	2563	4375	5563	6354
60	3025	5146	6271	6896

FRACTION KILLED

(30 ITERATIONS EACH)

MINE RANGE 150 METERS

SSPK	50	100	150	200
30	2438	4364	5417	6042
45	3354	5646	6625	6792
60	4125	6360	6833	7167

FRACTION KILLED

MINE RANGE 200 METERS

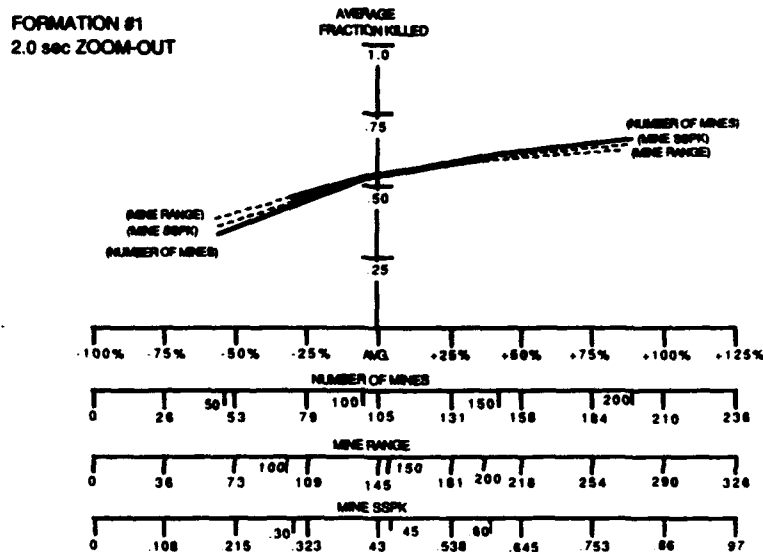| SSPK	50	100	150	200
30	2979	5271	6125	6563
45	4104	6229	6833	7063
60	4966	6563	7063	7458

FRACTION KILLED

The zoom-out evasive action is used in this scenario. The volley-fire delay was also taken out, for the previously stated reasons. These results would then appear to be a realistic worse case scenario, given the parameters studied. The minefield performs slightly less well than when the formation charged through with no evasive action, but not as well as with volley-fire

27. Average Results and Trends

DYNAMIC MODEL AVERAGE RESULTS AND TRENDS

FORMATION #1
2.0 sec ZOOM-OUT

AVERAGE
FRACTION KILLED

28. Static Model Results

STATIC MODEL RESULTS

FORMATION #2   16 HELICOPTERS   FORMATION WIDTH 200 METERS   ALTITUDE 50 METERS
MINE PATTERN 1000x1000

MINE RANGE 100 METERS
LANE WIDTH 373 METERS

	50	100	150	200	
30	3499	8888	9391	9850	FRACTION KILLED
45	5236	8680	9648	9890	
60	6330	8890	9692	9905	

MINE RANGE 150 METERS
LANE WIDTH 483 METERS

	50	100	150	200	
30	4536	8812	9884	9870	FRACTION KILLED
45	6621	9386	9888	99755	
60	7468	9484	9881	9976	

MINE RANGE 200 METERS
LANE WIDTH 587 METERS

	50	100	150	200	
30	5506	9615	9846	99827	FRACTION KILLED
45	7652	9700	9888	99835	
60	8234	9742	9880	999353	

The remaining results apply to Formation #2 (wide and short). This is where the great impact of formation width is seen. The wider the formation, the more mines which have potential to engage. From our perspective, the worse thing that could happen is to have the Soviets change their doctrine to flying ducks-in-a-column one right after the other. This situation gives them the greatest position variability within the avenue of approach, so we still have to cover the entire gap, and if they run into a minefield, a reduced number of mines can actually engage.

No trend curves are shown for this data.

29. Dynamic Model Results

DYNAMIC MODEL RESULTS

FORMATION #2   16 HELICOPTERS   FORMATION WIDTH 200 METERS   ALTITUDE 50 METERS
MINE PATTERN 1000x1000   MINEFIELD HOLD-FIRE UNTIL FORMATION AT CENTER
                              NO VOLLEY-FIRE DELAY

MINE RANGE 100 METERS

	50	100	150	200	
30	3084	6083	.8125	8863	FRACTION KILLED
45	.5167	.7896	.9846	.9917	
60	.8090	9642	.9979	1.000	

(30 ITERATIONS EACH)

MINE RANGE 150 METERS

	50	100	150	200	
.30	3667	6880	.9884	.9780	FRACTION KILLED
.45	5725	8625	.9780	9879	
.60	7104	9600	1.000	1.000	

MINE RANGE 200 METERS

	50	100	150	200	
30	4883	7521	9125	9696	FRACTION KILLED
45	6459	9375	9869	1.000	
60	7938	9750	1.000	1.000	

Continuing the same scenario changes for Formation #2 as with Formation #1, these next few tables and charts show the results. Nothing really special here, other than the performance levels being greater than Formation #1 and less than the static model, as expected.

30. Dynamic Model Average Results and Trends

DYNAMIC MODEL AVERAGE RESULTS AND TRENDS
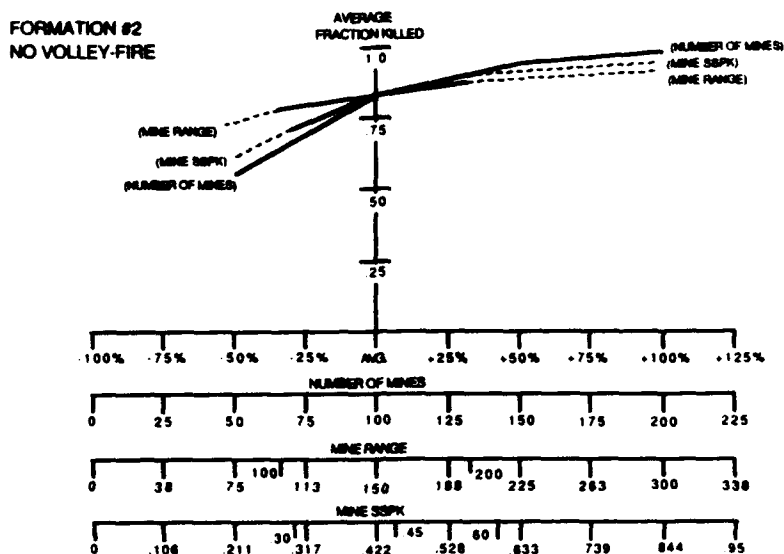
31. Dynamic Model Results

DYNAMIC MODEL RESULTS

FORMATION #2   16 HELICOPTERS   FORMATION WIDTH 300 METERS   ALTITUDE 50 METERS
MINE PATTERN 1000x1000   MINEFIELD HOLD-FIRE UNTIL FORMATION AT CENTER
                            ODD-EVEN VOLLEY-FIRE DELAY 6 SECONDS

MINE RANGE 100 METERS

	50	100	150	200
.30	.3375	.5613	.8392	.9875
.45	.5563	.8700	.9604	.9958
.60	.6300	.9865	.9979	1.000

FRACTION KILLED

(30 ITERATIONS EACH)

MINE RANGE 150 METERS

	50	100	150	200
.30	.4146	.7306	.9167	.9917
.45	.6479	.9125	.9888	1.000
.60	.7375	.9917	1.000	1.000

FRACTION KILLED

MINE RANGE 200 METERS

	50	100	150	200
.30	.4958	.8167	.9708	1.000
.45	.6771	.9729	.9979	1.000
.60	.8250	.9858	1.000	1.000

FRACTION KILLED

23

32. Dynamic Model Results

DYNAMIC MODEL RESULTS

FORMATION #2 16 HELICOPTERS FORMATION WIDTH 200 METERS   ALTITUDE 50 METERS

MINE PATTERN 1000x1000   MINEFIELD HOLD-FIRE UNTIL FORMATION AT CENTER
NO VOLLEY-FIRE DELAY 2.0 SECOND ZOOM-OUT DELAY

MINE RANGE 100 METERS

	50	100	150	200	
.30	.2708	.4479	.6146	.6617	FRACTION KILLED
.45	.3625	.5799	.8042	.8313	
.60	.4500	.6729	.8199	.9046	

(30 ITERATIONS EACH)

MINE RANGE 150 METERS

	50	100	150	200	
.30	.3208	.5417	.6999	.7750	FRACTION KILLED
.45	.5021	.6999	.8399	.8667	
.60	.5396	.8292	.8375	.9100	

MINE RANGE 200 METERS

	50	100	150	200	
.30	.3792	.6999	.7271	.8375	FRACTION KILLED
.45	.5500	.7364	.8454	.8679	
.60	.6208	.7917	.8555	.9100	

Something peculiar occurs in this one, where there is no volley-fire and the helicopters zoom-out. There are some reversals with respect to mine range, as highlighted. Looking at the model output, we found that increasing mine range above a certain point has a similar effect as not having volley-fire. that is, mines are wasted due to the positioning of the helicopters. With greater mine range, less mines are forced to hold fire until a helicopter is within range. Mine range, therefore, is sometimes a built in volley-fire command by default. This effect was hinted at in the scenario without volley-fire and zoom-out, but not conclusive, since the helicopters continue through and get killed later on anyway. With the zoom-out parameter, the mine range reversal effect is more pronounced because the helicopters leave the scene, not to be reengaged later on.

33. Dynamic Model Average Results and Trends

DYNAMIC MODEL AVERAGE RESULTS AND TRENDS
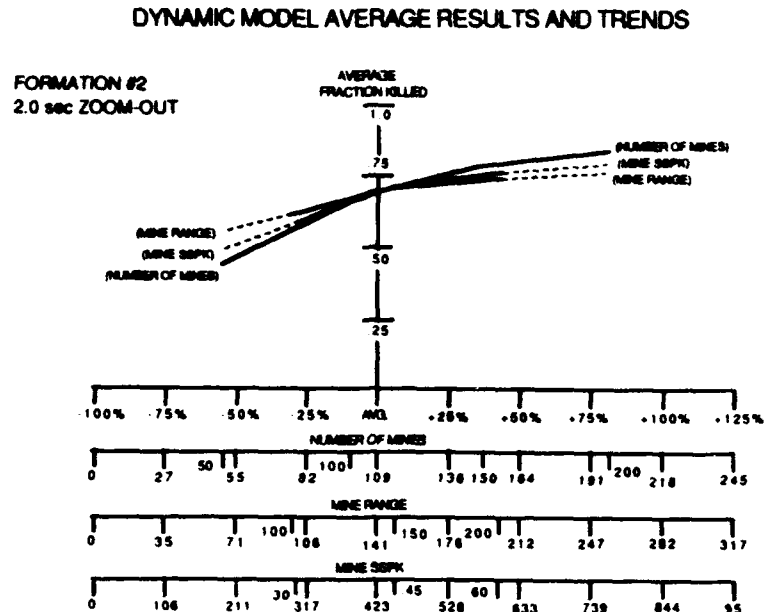
34. Conclusions and Recommendations

CONCLUSIONS AND RECOMMENDATIONS

- **Perform Theater Terrain Analysis**
  - Starting point for mine effective range
  - Assess other design and employment issues

- **Develop Confidence in Threat Assessment**
  - Assess simple tactical countermeasures
  - Evaluate flexibility and variability of formations shapes
  - Assess impact of having knowledge of mine capabilities

- **Analyze More Precise Scenarios**

The analysis is not complete until a theater terrain assessment or assessments have been performed. This is crucial to establishing a first cut at the minimum effective range of the mine. Just using the 50 meter doctrine for nap-of-the-earth is not sufficient, given all the other terrain factors. We need to quantify the variability for this height and correlate it with the terrain aspects of the theater of operations. There are other design and employment issues, which must also be quantified by a theater terrain assessment.

It was stated earlier that, although formation shapes are influenced by doctrine, terrain aspects are influential as well, and we need to understand how the Soviets adjust their tactics to terrain. We need to look closely at the threat to assess his flexibility in helicopter formations and how this will be affected by knowledge of anti-helicopter mines. Assuming that the enemy is too rigid to adjust to the situation is neglecting to consider that helicopters are high value assets worthy of preservation, and that pilots are generally more imaginative and skilled than the average Soviet soldier.

Once we have precisely defined the spectrum of scenarios and some quantitative assessment of each occurrence, more modeling analysis is needed to explore the tradeoffs among mine and minefield parameters.

References

SPC, "(Draft) Concept for the Anti-Helicopter Mine (AHM)," January 1989

V.F. Romasevich and G.A. Samoylov, Practical Helicopter Aerodynamics, USSR Ministry of Defense, Moscow, 1980